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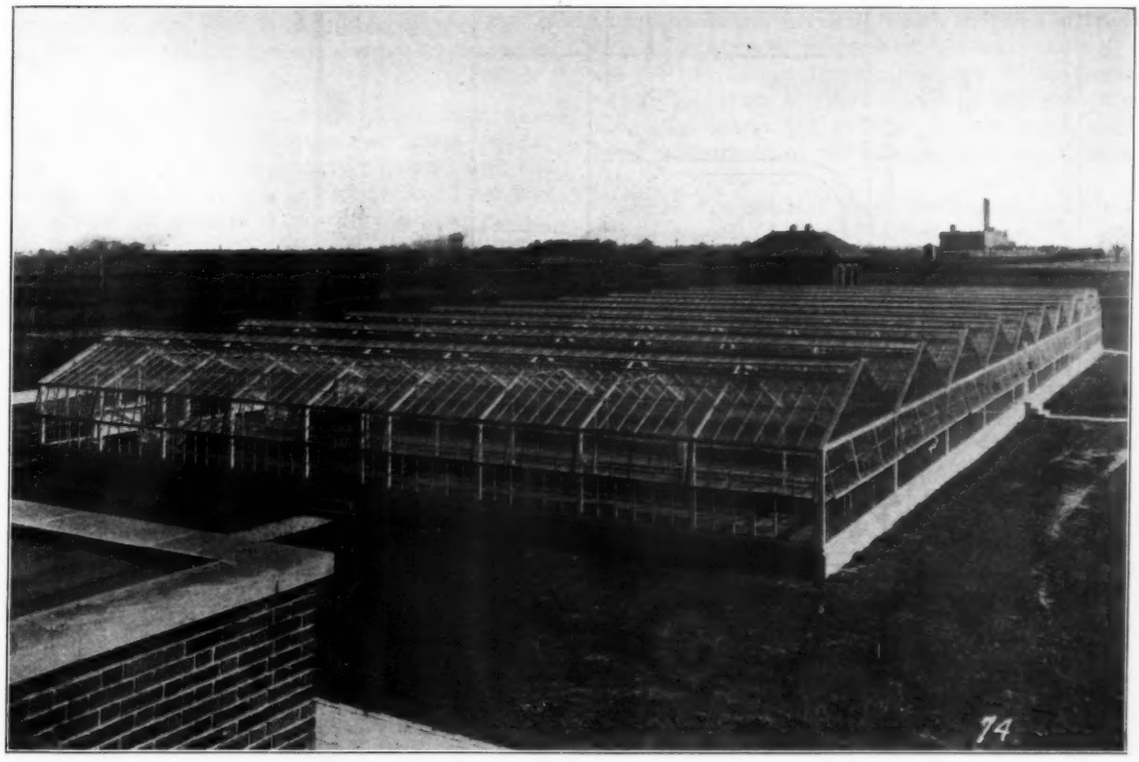


GLASS-COVERED SLUDGE DRYING BEDS AT MARION, O.

Sludge Disposal at Marion, Ohio

By Floyd G. Browne.*

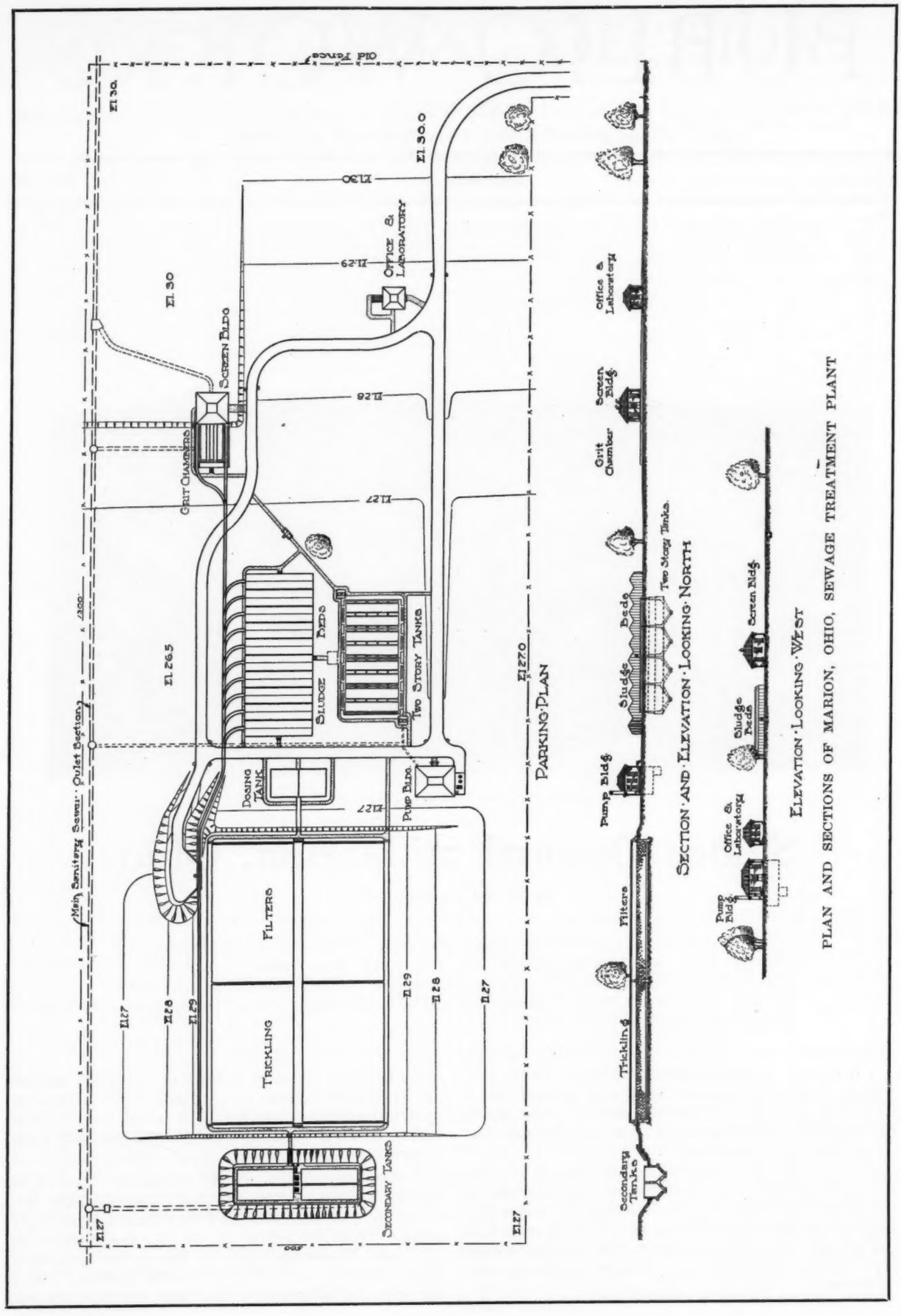
The Marion sewage treatment plant, which was described in PUBLIC WORKS *for October, 1926, has been in operation for five years, Mr. Browne having been in charge during the entire time. Only a small amount of sludge was used as fertilizer the first year, but recently considerable study has been made of this feature. Mr. Browne describes the result to date.*

The sewage treatment works at Marion, Ohio, were designed for a population of 40,000 persons. It is estimated that about 25,000 persons are connected to the sanitary sewer system, or about seventy per cent of the present population.

Due to the fact that the plant effluent is discharged into the Little Scioto river, which is one of the sources of water supply for Columbus and which during dry weather has a flow of about 1.5 cubic feet per second, complete treatment of the Marion sewage was deemed necessary. The primary treatment consists of sedimentation in Imhoff tanks, and the secondary treatment consists of oxidation and clarification by trickling filters assisted by a set of final settling tanks. This was the first of the modern plants in Ohio to give complete treatment throughout the year.

Primary treatment devices consist of hand-raked bar screens set to give 1½-inch clear openings, followed by grit chambers and four Imhoff tanks. The normal detention period of the grit chambers is 50 seconds. Screenings from the bar grates have averaged about two cubic feet per million gallons. Since the first year of operation very little grit has collected.

* Sanitary Engineer in charge of sewage treatment.



PLAN AND SECTIONS OF MARION, OHIO, SEWAGE TREATMENT PLANT

The secondary or oxidation treatment is provided by trickling filters which are 10 feet deep and 1.4 acres in area. The sewage flows by gravity through the Imhoff tanks to the wet well in the pump building, from which it is lifted to twin dosing tanks serving the filter beds.

The filter effluent passes by gravity to a set of four final settling tanks of the horizontal-flow type, with trough bottoms sloping to a sump located between the two sets of two tanks. The normal detention period is 45 minutes. Ordinarily the final settling tank sludge is pumped into the sludge chambers of the Imhoff tanks. The final effluent flows into the Little Scioto river.

The Imhoff tanks, of which there are four, have full length troughs as distinguished from hopper bottoms. Each tank is 30 by 60 feet in area and has a maximum depth of 29 feet below the flow line, thus giving a total capacity of 4.01 cubic feet per capita, of which 2.01 cubic feet is contained in the sludge compartment. The normal detention period is two hours. Provisions are made for reversing the direction of flow through the tanks. The gas vents, constituting about 18 per cent of the total tank area, are closed with hinged wooden covers. Wooden scum racks placed six inches below the flow line in the gas vents keep the scum submerged and porous, thereby permitting the escape of gases with comparative ease. Two-inch water lines are located conveniently for stirring up the sludge, either for mixing or to assist in its removal. Sludge from the digestion chambers flows by gravity to a pneumatic sludge ejector, from which it is forced by air onto the sludge drying beds. Sludge can be transferred from one tank to another by gravity for seeding or mixing purposes. Provisions are made for pumping the secondary tank sludge into the sludge compartments of the Imhoff tanks.

The sludge drying beds are ten in number, each having an effective drying area of 17 by 74 feet, making a total drying bed area of 12,580 square feet. The per capita area is 0.314 square foot based on 40,000 persons, or 0.5 square foot based on the present connected population. The depth of sand is twelve inches, overlying two inches of gravel and a six-inch tile drain with open joints. The entire sludge drying area is enclosed by glass of standard greenhouse construction, thus making it possible to dry sludge at all seasons of the year.

Marion's sewage is essentially a strong domestic sewage, containing little trade waste other than occasional oil. It varies in suspended matter from 100 parts per million to 400 parts per million, and in B.O.D. from 25 parts per million to 500 parts per million; the concentration depending upon infiltration and the entrance of storm water into the sanitary system. The ash content of the fresh sewage solids varies from about 15 per cent to 40 per cent, the average being about 25 per cent. The flow varies from a minimum of 35 gallons per capita per day in dry weather to a maximum of 435 gallons during heavy storms.

OPERATING DETAILS

The temperatures obtained in the digestion compartment of the Imhoff tanks have varied from a minimum of 48 degrees Fahr. to a maximum of 68 degrees Fahr., the average being about 56 degrees Fahr. The relation between air, sewage and sludge temperatures is shown in the following table:—

Table No. 1

Temperature in degrees Fahrenheit

	Air Temperatures			Sewage Temperatures			Sludge Temperatures		
Year	Mean Annual	Max.	Min.	Mean Annual	Max.	Min.	Mean Annual	Max.	Min.
1925..	52.1	97	-6	59	68	46	57	68	50
1926..	50.7	98	-7	57	70	48	55	66	48
1927..	51.9	94	-2	59	70	50	57	66	50
1928..	51.2	93	-5	56	72	46	56	66	48

Except to control foaming, which occurred at the start of plant operation, no attempt has been made to control the pH of the digesting sludge. It has been the policy to operate all the tanks with the sludge compartments nearly full of sludge, only small amounts being withdrawn as the sludge level approaches the slots.

The sludge obtained from the Imhoff tanks has the characteristics of good Imhoff sludge. It is well digested and granular, has a black tarry appearance, and when dried the odor is the typical earthy odor. When first withdrawn from the tanks, the hydrogen sulphide present in the entrained gases escapes and gives off that unpleasant odor.

The moisture content of the wet sludge varies from 5 per cent to 12 per cent, with an average of about 7.5 per cent. The ash content of the sludge withdrawn from the tanks has varied from 45 per cent to 53 per cent, the average being about 50 per cent. The pH of the sludge varies in value from top to bottom of the sludge in the compartments, the sludge supernatant having a pH of 6.8 and the sludge having pH values of 7.2 to 8.2.

Frequent fertilizer analyses of the sludge show that the following constituents are present:—

Nitrogen as N..... 2.0 to 3.0 per cent
Total phosphoric acid (P_2O_5)..1.75 to 2.5 per cent
Potash (K_2O)..... 0.1 to 0.2 per cent

In general, a great deal more progress has been made in sludge digestion than in sludge disposal, although it follows that a well-digested sludge can be disposed of more easily and with less offense than a poorly digested sludge. With a well digested granular sludge, sludge drying under glass has proved at Marion to be both satisfactory and economical, as well as independent of the weather.

The measure of sludge drying bed efficiency is, first, how quickly will the sludge dry, and second, how much sludge can be dried per square foot per year. Of course, neatness, compactness and odor control are factors worth considering too. After some experimentation on depths of application, it was found that 10 inches of wet sludge averaging 7.5 per cent solids was the optimum depth, and that, with favorable weather and temperatures, it could be removed from the beds on the sixth day after application with an average solids content of 35 per cent. However, the usual drying period for a 10-inch application of wet sludge is seven to ten days. During the four winter months, one drying a month usually is obtained. During the summer months, it is possible to dry sludge to a cake having less than 10 per cent moisture.

During 1929, there will be twenty complete removals of dried sludge from two beds that were set aside for the purpose of definitely establishing the

INTERIOR VIEW OF MARION GLASS-COVERED SLUDGE BEDS

number of dryings it is possible to obtain in one year under glass at Marion, and these dryings were obtained in 320 days. A total of 1440 cubic yards of wet sludge was placed on the two beds, or 15.5 cubic feet per square foot, containing about 7.5 per cent solids, and it was dried to a cake with an average solids content of 35 per cent, with a maximum of 55 per cent and a minimum of 21 per cent. This is about two and one-half to three times as much as can be dried and removed from open beds in this climate.

Temperatures inside the glass covered sludge drying beds are somewhat higher than atmospheric temperatures, as the following table shows, for example, for the year 1927:—

Table No. 2

In degrees Fahrenheit

Month	Air Temperature		Bed Temperature Max.	Bed Temperature Min.	Number of fair days
January	50	—2	86	14	14
February	67	16	110	20	12
March	72	17	90	20	12
April	81	28	104	30	14
May	86	35	110	38	15
June	93	43	119	45	19
July	94	49	128	53	23
August	91	45	120	47	21
September	94	40	112	41	23
October	88	34	114	34	23
November	75	23	96	23	10
December	62	4	85	8	16

The final step in sludge disposal usually consists in removing the dried sludge from the beds to a dump, or giving it away to those who can use it, such as farmers and gardeners. The Imhoff tank sludge at Marion is a low-grade fertilizer containing some nitrogen and phosphoric acid and about 50 per cent organic matter. For the heavy clay soils in and about Marion, the organic or humus content is as valuable as the fertilizing constituents when applied to gardens and lawns. Marketing the sludge as a fertilizer has been attempted, both to obtain some revenue to help pay the cost of sludge disposal, and to keep the plant free of what would be a constantly increasing pile of dried sludge. Any surplus above the actual cost of sludge handling is "velvet."

Imhoff sludge is sold as it is removed from the drying beds or sludge dump, and from a pit in which the sludge weathers to something like leaf mold, at $2.00 per cubic yard at the plant site, or $4.00 per cubic yard delivered in Marion. When dried to about 5 per cent moisture on the drying beds, pulverized and sacked, it is sold at $1.15 per hundred pounds or $20 per ton in small lots, and correspondingly lower prices for larger lots to a minimum of $14 per ton.

Several golf clubs have used the fertilizer on fairways and greens with considerable success, florists and truck gardeners have found it a valuable addition to existing garden soils, and it has been used by residents of Marion as a turf starter or for accelerating the growth of lawn grass with equal success. However, the market is limited pretty well to the immediate vicinity of Marion or those communities that have no sewage plants, as every sewage plant treating domestic sewage is a possible source of a low grade fertilizer for its own vicinity. Newspaper advertising and the selection of demonstration plots in locations that

were easily observed by passers-by informed the public of the value of Marion sludge as a substance supplying both plant food and organic matter, so that at the present time repeat orders for sludge are frequent. However, attention is directed at present towards selling the entire output of pulverized sludge to fertilizer mixing plants as a filler for more concentrated fertilizers in place of sand or bean meal. Used as such, sludge supplies the extra bulk needed and also organic matter in place of inert sand.

It was never contemplated at Marion that the sale of Imhoff tank sludge as a fertilizer would pay the full cost of plant operation, but it will pay for the cost of sludge handling as well as eliminate the problem of finding adequate dumping grounds. It will supply a low-grade fertilizer to take the place of a diminished supply of stable manure, which was used for years by the urban population on lawns and gardens. Considerable advertising, demonstrating and salesmanship efforts were expended at first to convince the public that the sludge was a good fertilizer and worth the money, but once convinced, the public now takes the entire output of sludge from the Marion plant. However, in the case of a small plant it is difficult to justify the added expense to plant equipment of special drying and pulverizing equipment in order to prepare the sludge in a more useable and valuable form, and for that reason the greater proportion of our sludge is sold in cake form.

The personnel required to operate and maintain the plant consists of a superintendent (who is the chemist) an assistant superintendent and foreman, three operators and two laborers.

The cost of operating and maintaining the works is about $18,300 per year, divided as follows:

Salaries and labor	$13,500
Power	2,100
Equipment, maintenance and repairs	2,700

The Marion sewage treatment plant was designed by George B. Gascoigne of Cleveland, Ohio and constructed by A. Bentley and Sons Company of Toledo, Ohio. The cost, including 80 acres of land and equipment, was $539,200. The plant is operated by the Service Department, O. A. Benedict, director, with F. G. Browne in immediate charge of operation, assisted by R. E. Burnett, assistant superintendent and foreman.

Devices for Weighing Concrete Aggregates

The American Road Builders' Association now has a committee at work on the standardization of weighing devices for concrete aggregates. A check of the specifications of the various State highway departments shows that at this time 27 of these departments either require that the aggregate for concrete work be proportioned by weight or make it optional as to whether the proportioning be done by weight or volumetric measurements.

In the 27 departments there is a wide range in the requirements for weighing devices, with the result that manufacturers are required to build and carry in stock many different types of the same equipment. For instance the type of weighing hopper that is acceptable to the State Highway Commission of North Carolina can not be used in South Carolina and the weighing hopper that is used in Iowa may not be accepted in Minnesota.

The Association feels that if a standard can be reached which will be acceptable to all States, a real service will have been rendered to the contractors and manufacturers. The manufacturer, by carrying so many different types of weighing equipment, increases his cost of production very materially with the result that the selling price of the equipment is notably increased.

Mr. P. M. Tebbs, assistant chief engineer of the Pennsylvania Department of Highways, has accepted the chairmanship of this committee and will have associated with him, on this work, State highway officials and manufacturers of equipment. Active work by this committee is now in progress, with investigations and research being conducted by Mr. Perry Seward, American Road Builders' Association assistant engineer.

Annual Report of the New Jersey Sewage Experiment Station

We have been informed by Prof. Willem Rudolfs that, while it has been the practice of the New Jersey Agricultural Station to send its annual reports to a considerable number of interested persons, this year the Publications Department of the Station had insufficient funds to do this, but the report has been printed and will be distributed at cost.

The report, bound in a durable paper cover, contains the following studies:

1. Operation of two separate sludge digestion tanks.
2. The color of sewage sludges.
3. Effect of freezing on sludge digestion.
4. Effect of dye manufacturing wastes upon sludge digestion.
5. Effect of reaction on gas production from sludge.
6. Studies on the function of ripe sludge.
7. Effect of sterilizing fresh solids on the digestion of seeded mixtures.
8. Prolonged sludge digestion.
9. Decomposition of pure substances in sewage.
10. Effect of the addition of certain pure substances on the digestion of seeded mixtures.
11. Decomposition of oils and bacterial numbers.
12. Changes in composition of gas during digestion of fresh solids.
13. Changes in composition of material suspended in supernatant liquid.
14. Notes on substances in the supernatant liquid and foaming.
15. List of references.

The report can be obtained from the Mailing Clerk, N. J. Agricultural Experiment Station, New Brunswick, N. J., at 50 cents a copy, prepaid, checks or money orders being made payable to New Jersey Agriculture. The edition is limited and will not be reprinted when exhausted.

Sanitary Aspects of the Lake Michigan Diversion Case at Chicago

By L. R. Howson*

The Chicago lake diversion case has for several years been exceedingly interesting to sanitary engineers, many of whom have served as experts either for the Sanitary District or against it. Among the latter is the author of the following paper, who, however, has endeavored to present the sanitary aspects of the case without prejudice or bias. In fact, we believe that the only feature of this paper (which was read before the American Society for Municipal Improvements in October) to which the other side would take exception is his interpretation of the limitations and injunctions as to lake diversion, from a legal point of view of the court decision. This interpretation affects the extent to which the sewage and/or water supply must be treated to meet the legal requirements, as partly indicated in the next to last paragraph of the paper; but does not affect the correctness of the statements made herein as to how such degree of treatment can be effected or the results to be obtained by the treatment methods considered.

Chicago and the industrial region adjacent to it occupy the southwestern shore of Lake Michigan. The topography is comparatively level and most of the ground lies at an elevation less than 20 feet above Lake Michigan. The city started near the mouth of the Chicago river, which was a small sluggish stream with a total drainage area of approximately 307 square miles, being made up of two branches known as the north and south branches, which unite about one mile west of the mouth of the river.

The first sewers, as well as the first municipal water system, were built in 1856, at which time the city had a population of about 80,000 people. The occupied area was then so located that most of the sewers naturally drained directly to the main branch of the Chicago river and thence discharged directly to the lake. The population at the present time exceeds 3,500,000 in the Sanitary District.

The discharge of the sewage into the lake within close proximity of the water works intakes resulted in high rates of water-borne disease in the Chicago District, the typhoid death rate reaching a peak figure of 173.8 per 100,000 in 1891.

In 1886 a drainage and water supply commission, known as the Hering, Artingstall and Williams Commission, advised the construction of the drainage canal with a capacity of 10,000 cubic feet per second which would divert the entire sewage from the lake and discharge it, mixed with water drawn from the lake, into the upper Des Plaines river and thence into the Illinois and Mississippi. As an outgrowth of this report, the Chicago Sanitary District was created in 1890, and 1901 saw the completion of a channel extending from a connection with the south branch of the Chicago river at Robey street to a connection with the Des Plaines river near Lockport, a distance of some 28 miles. Since that date, the flow of the Chicago river has been *from* rather than *into* Lake Michigan.

The Calumet District to the south and east of Chicago continued to drain into Lake Michigan, but a channel, known as the Calumet-Sag channel, with a capacity of 2,000 cubic feet per second, was completed in 1922 to divert the normal flow of the Calumet river from Lake Michigan to a connection with the drainage canal; and since that date, the flow of the Grand and Little Calumet rivers also has been *from* rather than *into* Lake Michigan at such times as the stream flow did not exceed the carrying capacity of the canal and its connections.

The construction of the main drainage canal and the Calumet-Sag branch effected a remarkable improvement in the Chicago death rate from water-borne disease; also it to a large extent removed the sewage nuisance from the Chicago and Calumet rivers but transferred it to the Des Plaines and Illinois rivers, in which all fish life has been killed and other damage resulted for more than 100 miles downstream. The Des Plaines and Illinois rivers today are practically an open sewer for 150 miles from Chicago.

The important facts with respect to the typhoid death rate in Chicago are as follows:

Ave. for 5 years prior to opening of canal reversing flow	34	per 100,000
Ave. for 5 years after opening of canal reversing flow	28.4	" "
Ave. for 5 years after completion of intercepting sewers diverting sewage from the lake	12.1	" "
Ave. for 5 years after the pasturization of milk and the start of water chlorination	5.9	" "
Ave. for 5 years after complete chlorination of water supply	1.2	" "

On January 14, 1929, the Supreme Court of the United States delivered an opinion in a suit started about three years ago with regard to the diversion of water by the channels above referred to, which opinion denied the right of diverting water at Chicago except that negligible quantity, if any, which might be required for navigation in the Chicago river as a part of the Port of Chicago. In keeping, however, with the principles on which Courts of Equity condition their relief, and by way of avoiding any unnecessary hazard to the health of the people of the Chicago section, the Supreme Court decided to so frame its decree as to accord to the Sanitary District a reasonably practicable time in which to provide some other means of disposing of the sewage, at which time there

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shall be a final permanent operative and effective injunction. The special master, Charles Evans Hughes, was instructed to take such further evidence as would enable him to advise the court as to:

1st. What negligible amount, if any, of diversion was necessary for navigation in the Chicago river as a part of the Port of Chicago.

2nd. What sewage disposal works would be necessary to care for the sewage of the Chicago District by means other than diversion.

3rd. What period would be required for the construction of such works.

This decree, when effectively carried out, will result in a part or all of the sewage plant effluent and storm water overflow being discharged into Lake Michigan,* from which the water supply is taken. The water supply and sewage disposal problems at Chicago are and always have been one problem, though administered by two governmental agencies.

Sewerage in the Chicago Sanitary District is almost entirely on the combined system, although the Hering, Artingstall and Williams report made in 1887 recommended separate sewers for the then outlying areas. Had that recommendation been adopted, nearly 80% of the present sewer mileage would have been on the separate system and over 50% of the population would have been tributary thereto, and the problem of building intercepting sewers and of caring for storm-water overflows would have been much simplified.

The Sanitary District is now carrying out a comprehensive sewage disposal program which includes four major and several minor projects, as follows:

The North Side sewage treatment works, an activated sludge plant designed to serve approximately 800,000 people. Completed.

The West Side project, to serve 1,915,000 people as of 1945; started as Imhoff tank treatment only, later to be followed by sprinkling filters, but since the Supreme Court decision, modified to make it an activated sludge plant.

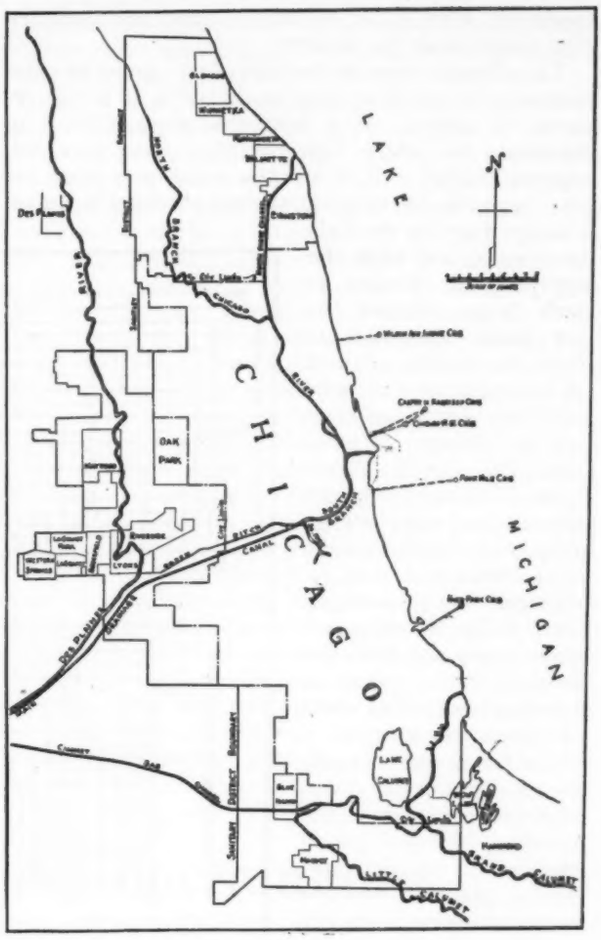
The Southwest Side plant, located directly across the main drainage canal from the West Side plant; planned to be an activated sludge plant to serve 1,320,000 people in 1945, to handle the large stockyards organic load. Not yet started.

The Calumet project, designed as an Imhoff tank and trickling filter plant to serve approximately 400,000 people. The tanks have been in operation approximately seven years. The sprinkling filters and secondary sedimentation are now included as a part of the Sanitary District's program to comply with the requirements of the United States Supreme Court.

EFFICIENCY OF SEWAGE TREATMENT

While there has been some divergence of opinion, as reflected in the testimony, as to the quality of an activated sludge effluent, the operation of the Milwaukee plant, the largest yet in full operation, has demonstrated that the effluent from such an activated sludge plant in the sizes contemplated for Chicago will be practically clear, odorless, colorless and stable and that the process will have removed at least 95% of the suspended solids, at least 95% of the bacteria,

*There seems to be a question whether or not the decision would prevent the city from continuing to discharge into the Des Plaines river, through the drainage canal, all its sewage, and possibly also the flow of the Chicago River. —Editor.



CHICAGO SANITARY DISTRICT, SHOWING DRAINAGE CHANNELS AFTER DIVERSION

These channels are the North shore channel, extending north from the North Branch to Lake Michigan; the drainage canal, from the South Branch to the Des Plaines river; and the Calumet Sag Channel, west from the Little Calumet.

98% to 99% of the b. coli and 96% of the biochemical oxygen demand. It will contain 5 to 7 p.p.m. of dissolved oxygen, and oxygen in the form of nitrates and nitrites up to 15 p.p.m. Based upon the Milwaukee operating experience, the remaining B.O.D. will be about 10 p.p.m. or less. It will be permanently stable; that is, it will not again putrefy if stored in an open vessel or discharged into a water course in which it constitutes the total flow.

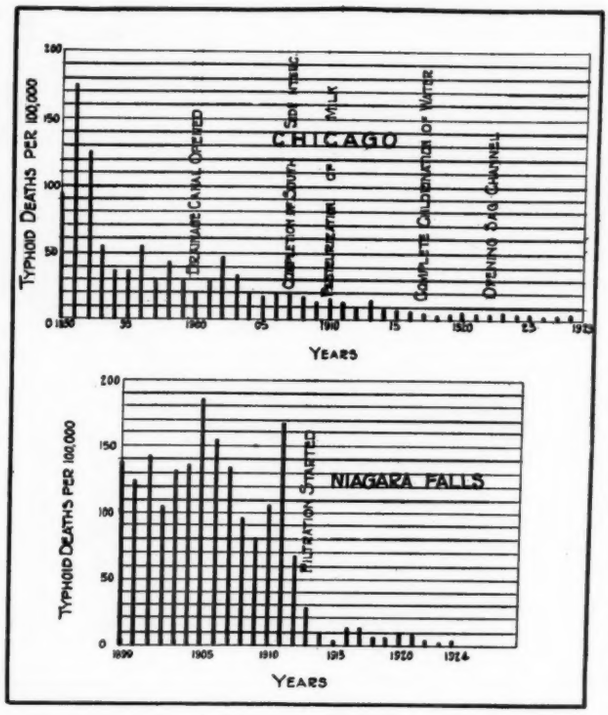
With a combined system of sewers, all of the sewage flow cannot be passed through the disposal plant on account of the relatively high ratio of storm water to sanitary flow. This necessarily results in the by-passing of some sewage during storms. It has been estimated that approximately 1½% to 2% of the sewage flow may reach the river channels untreated during the year, the exact percentage depending quite largely upon the capacity of the interceptors and the proportion of first storm flows which are carried through the plant.

The amount of storm water which could be discharged into the various water courses if all of the sewers were running full is approximately 12,000 c.f.s. The interceptors are capable of taking about 4000 c.f.s. to the disposal plants, so that in extreme

conditions 8000 c.f.s. of mixed storm and sanitary flow would reach the streams.

The effluents from the various plants could be chlorinated so as to effect practically 100% of b. coli removal if desired. It is somewhat more difficult to chlorinate the storm water overflow from over 300 separate outlets. All of this flow which may reach the lake, however, has to pass out through either the main Chicago river or the Calumet river; and while the applying of chlorine to such large volumes has not been attempted to date, the results obtained in chlorinating raw sewage in large volumes would indicate its practicability. At the Cleveland Easterly plant, where the raw sewage from over 500,000 people is chlorinated, b. coli reductions have averaged over 96% for the past three years and have exceeded 99% when a chlorine residual of about .3 p.p.m. was carried.

So far as the sanitary aspect of the water diversion case is concerned, the question becomes one of the effect of activated sludge plant effluent and storm water overflows primarily upon the water supply and to a lesser extent upon the bathing beaches.



TYPHOID FEVER DEATH RATES IN CHICAGO BEFORE AND AFTER DIVERSION AND IN NIAGARA FALLS BEFORE AND AFTER FILTRATION.

THE CHICAGO WATER SUPPLY

The Chicago water supply is drawn through four intake cribs located from three to four miles off shore and connected by tunnels to the twelve major pumping stations. The water receives no treatment other than chlorination.

About two-thirds of the time, the water drawn from the Chicago cribs is clear. It is often quite pure for short periods. However, its sanitary quality cannot be depended upon and for a considerable portion of the time it is distinctly bad at all of the intake cribs. The water as delivered to consumers is often decidedly turbid for weeks at a time.

During 1927, the turbidities varied from 1 to 115 p.p.m., with a yearly average of 11.5 p.p.m. for all stations and 17.8 p.p.m. at the 68th Street crib. The water from the 68th Street crib had an average turbidity for a month of 50.4 p.p.m.

From a sanitary standpoint the water as chlorinated has been good. The taste is frequently objectionable and the turbidity for approximately 30% of the time averages more than 10 parts per million.

Filtration of the present water supply has been recommended by all conversant with the problem for a number of years. Filtration, however, carries with it the prerequisite of metering; for at the present time, Chicago is pumping approximately 300 gallons per capita per day, and the cost of filtration plants sufficient to care only for the water wasted would approximate $30,000,000. It has been estimated that if Chicago were to install meters on all services within a ten-year period, there would be saved in the next twenty-five years $233,000,000 in operation and construction costs. In addition, it has been estimated that approximately $50,000,000 would be saved in the cost of intercepting sewers and sewage disposal plant construction. With complete metering, the quantity of water pumped (which is assumed to be substantially the same as the sewage flow) will be approximately 1000 cubic feet per second between 1935 and 1940.

WHAT FILTRATION WILL ACCOMPLISH

Filtration has demonstrated its ability to treat highly polluted waters satisfactorily. Among the notable examples are Niagara Falls and the Ohio river cities.

Niagara Falls, whose source of water supply is polluted by the fresh sewage of Buffalo and environs, was one of the most important typhoid centers of the country prior to filtration in 1913. The typhoid death rates were as high as 185 per 100,000 and averaged 125.8 per 100,000 for the fourteen years preceding filtration. Following the start of filtration, there were 18 months with no deaths from typhoid, and the average typhoid death rate since filtration has shown a reduction of over 95% from that prevailing prior thereto.

On the Ohio river, city after city from Pittsburgh to Cairo takes its water supply from the river, and returns it again to the stream as sewage, the water being used again and again by the cities downstream after filtration. The b. coli index of the raw Ohio river water frequently exceeds 100,000, but filtration and chlorination produce from it a safe water supply.

In addition to the bacterial removal, filtration will, of course, remove the turbidities now prevailing in the Chicago water supply. Filtration will insure a clean water for Chicago 365 days in the year. It should be installed at Chicago regardless of whether the diversion from the lake is zero or 10,000 c.f.s.

CHICAGO'S PROBLEM

The Supreme Court having already decided that all diversion shall cease except such negligible amount (if any) as may be required for navigation in the Chicago river, the Chicago District is confronted with the necessity for devising such means of caring for its sewage and of protecting and purifying its water supply as will adequately safeguard the public health.

Among the measures available to accomplish this result, are the following:

1. The treatment of all sewage, other than storm-water overflow, through the most efficient type of treatment plants, which experts on both sides have agreed to be the activated sludge process.
2. The chlorination of the sewage disposal plant effluents.
3. The chlorination of all storm-water overflows by carrying a residual chlorine content of approximately .3 part per million in the liquid flowing into the lake through the Calumet and Chicago rivers.
4. The metering of the water supply, which will make filtration practicable.
5. The filtration of the public water supply, utilizing the present intakes and standard filtration methods.
6. The abandonment of those intakes nearest to the mouth of the rivers and the substitution therefor of a super-intake located approximately twenty miles to the northeast of the mouth of the Chicago river.
7. The modification of the standard filtration processes by double coagulation, as is extensively practiced on the highly polluted Ohio river supplies; or the adoption of excess-lime treatment.
8. Sanitary control and sterilization of the bathing beaches.
9. Should the Supreme Court allow a diversion from the lake for navigation purposes in the Chicago river equivalent to the water supply and the run-off from the Chicago river watershed, it would be practicable, through the operation of controlling works located at the river mouth or at the head of the canal, to prevent any outflow of either sewage plant effluent or storm overflow to the lake. The protection to the beaches and water supply would then be much more positive than now exists.

Opinion as expressed in the hearings before Mr. Hughes has differed as to the measures or combination of measures which might be necessary to adequately safeguard the public health, and the writer does not intend in this paper to discuss these controversial matters. It must, however, be apparent that if sanitary engineering science has not sufficiently developed to safeguard the health of the Chicago community through a combination of sewage treatment and water purification works, a large part of the population of this and other countries is destined to live under unsanitary conditions. Chicago, in contrast to Milwaukee, Cleveland, Toledo, and other important lake cities, is the only one at which diversion from the lake was a practicable possibility. Can anyone sucessfully argue that Cleveland or Milwaukee must cease to exist because of the necessity for living under conditions which are now to be imposed upon Chicago? The facts are that Cleveland's typhoid death rate with water filtration but with only 10% to 15% sewage treatment, and Milwaukee's with complete sewage treatment but with chlorination only of its water supply, are substantially the same as Chicago's under the present conditions of diversion from Lake Michigan. Certainly, Chicago with proper treatment of its sewage and with adequate purification of its water supply can continue to function and expand without detriment due to the decision of the Supreme Court. Any disagreement of sanitarians must be towards the *means* of accomplishing the result rather than the *ultimate practicability* of it.

Refuse Disposal At Sacramento

By substituting motor equipment for horse-drawn, salvaging paper, and business-like administration, the department increased its net revenue thirty thousand dollars

Sacramento has a population of 110,000, having grown from 65,000 in 1920. With this 70% increase of population has developed a serious problem in the disposal of the city's refuse. This has been met by a reorganization, last fall, of the Garbage Department, to increase both its efficiency and its economy. (The term "garbage" is used in parts of the far west to describe all wastes, rubbish being termed "dry garbage.")

Household garbage, ashes and combustible rubbish are burned in an incinerator, except a small amount which is dumped on low land, and the paper, which is sold. Garbage from hotels and restaurants is sold to a hog company for $2.76 a ton.

In 1928 the Department had a net revenue of $44,824, which was expected to reach $74,000 for 1929. The $30,000 increase is said, by Harry A. Kluegel, city manager, to be due to the business-like administration of the department by William McQuillan, superintendent of the department, who made a thorough preliminary survey of the operation of the department, followed by a reorganization of equipment, routing, personnel, and obtaining additional revenue from sale of waste paper and of garbage for hog feeding.

There were formerly 24 collection districts or routes, but these were reduced to 18, which was made possible by substituting automobiles for horse-drawn vehicles. Formerly the collection equipment consisted of 9 horse-drawn vehicles, with two horses each and a dump body capable of holding 5 cubic yards, the city owning the wagons and hiring the horses and drivers at $33 per month; 3 "Standard" trucks with dump body capacity of 7½ cubic yards; and 10 Model T Ford trucks with a dump body capacity of 3 cubic yards. A snap team consisting of two horses and a driver was maintained at the incinerator to assist the horse-drawn vehicles up the ramp.

In replacing the horse-drawn equipment, automotive equipment was purchased sufficient to permit the retirement of 3 old Ford trucks also, which are still retained and available for emergency purposes. The type of truck selected as most suitable for refuse collection was the Model A. A. Ford truck complete with cab, Ford dual high transmission, low-speed worm-drive, Pierce Model A A truck governor, Rowe 20-inch extension frames and W & K web steel wheels, dual wheels in the rear and single wheels in the front. Tire equipment for trucks consists of seven 8-ply heavy-duty 30x5 truck tires. The bodies of the trucks are 3¾ x 6 rear-end dump, with underbody two-speed hand hoist, 9 feet long, 6 feet wide, forward end 3 feet high, rear end 3 feet high, 22-inch sides with rolled edges with provision for 14 ft by 2 ft. side board. The material used in the construction of

the body is U. S. standard No. 10 gauge steel. Eight of these trucks cost $11,158. There was allowed in 1928 for horse hire $13,860, and for a barn man $1,551, or a total allowance of $15,411. This left available, with an equivalent budget for 1929, $2,621 for repairs, tires, equipment, replacements, etc., for the eight trucks in addition to total purchase cost of same. The reducing of the number of districts made possible the elimination from the payroll of five of the fifty-five garbage collectors, effecting a saving of $6,855; also $1,381 formerly paid for the snap team and driver.

On April 1, 1929, the city took over the sale of waste paper, which had formerly been in the hands of the Standard Garbage Men's Association, composed of the garbage collectors employed by the city. This change corrected a great evil, for the men had formerly been so busy with this "private" business that they neglected their duties as city employees. In making this change, the city increased the wages of these collectors 25c a day. For this paper the city receives from the Independent Paper Stock Co. $5.25 a ton, or an estimated total of $13,500 a year.

In preparing the refuse for collection, the occupant of each house is required by law to provide regulation garbage cans with close-fitting covers, which must be placed in an accessible place, and when filthy, leaking, or in any way defective, must be replaced by a new can—a 20-gallon size is recommended. "It is suggested for sanitary reasons and the reduction of the cost of incineration, that garbage be drained of all moisture and wrapped in paper before being placed in the can. This will, in addition, prevent the attraction of flies and prevalence of bad odors." In this can are to be placed all garbage, ashes, cans, floor sweepings and other refuse that will burn. Newspapers and waste papers are to be placed beside the can. Cans which contain water, dirt, plaster, etc., will be emptied only on special call. Collection of garbage is made six times a week in the business districts and twice a week in the residential districts. The "wet garbage" in hotels and restaurants is kept separate and taken directly to the hog farm.

The waste is transported in trucks with water-tight steel tank bodies of 6 cu. yds. capacity, which are constructed so as to be cleaned and flushed easily, the interior surface being smooth, with rounded edges. The bodies are low so that a collector can empty cans into them without undue strain of lifting. Tarpaulins have been found to be the most efficient covers to prevent the spread of odors and loose garbage. A tarpaulin cover is costly, wears out quickly, and grows dirty easily; but it does not rattle, and permits the heaping of loads during the period when the amount of garbage is at a maximum. Steel and wood covers, when used on collection wagons, are built in sections but wear loose, get broken, and are noisy and heavy. These bodies dump in the rear through a tail gate. At the close of day the trucks are thoroughly washed, cleaned and disinfected at a disinfecting plant maintained at the city corporation yard. This plant consists of a large enclosed sump and tank and hose equipment with a 350-pound pressure. Four trucks at a time are placed in this plant and cleaned with the high-pressure hose, and come out perfectly clean with all germs killed by disinfectant.

Daily reports are kept for each route, showing at a glance the number of houses visited, number of calls, kinds of refuse collected, complaints and their reasons, payments for service, operating cost, etc.

The department charges the citizens for the collection service rendered on the basis of fees provided by a city ordinance. Prior to December 1, 1928, billing for service was made at the end of each month, but this was discontinued at that date and bills made payable in advance, this being deemed necessary in order to minimize losses due to the removal of patrons as well as to effect a prompt payment of bills. It had been necessary for the garbage department to receive a refund from the general fund to cover the sum represented by uncollectable accounts. The sum of $23,460 owing the department on December 1st of last year had been reduced to $15,438 by July 1st of this year by the new procedure.

The Sacramento Hog Co. operates a hog farm located ten miles from the city hall, in a thinly populated section of Sacramento County. The farm is under strict sanitary regulations of the city and its management is in the hands of the garbage department. Here there is a modern plant containing between 2,000 and 3,000 hogs of high grade, a fine herd of Maltese boars having been imported for breeding purposes. The entire plant is thoroughly cleaned daily.

The city incinerator is located on the northern outskirts of the city and has a capacity of 15 tons per hour.

In operating the department, the management has stressed the idea that sanitation and not profit is the primary consideration; has endeavored to introduce modern methods of business management and eliminate politics and graft; and to give good service at the lowest possible cost.

Sewage Treatment in Kansas

Kansas is making notable progress in constructing modern sewage treatment works. Topeka has just completed a plant for primary treatment and chlorination, using a detritor, mechanical screen, Dorr clarifiers, and covered digestion tanks, with gas collection, heated by hot water. C. A. Haskins, Kansas City, was the engineer.

Ottawa, population about 10,000, is constructing a plant of the activated sludge type, Black and Veatch being the engineers.

Olathe, a town of about 3500, is constructing an Imhoff tank and sprinkling filter plant under the supervision of the E. T. Archer Engineering Co. of Kansas City.

At Newton an Imhoff tank and sprinkling filter installation is being reconstructed by Black and Veatch, changing the Imhoff tank into a vertical settling tank and providing separate sludge digestion for a town of approximately 10,000.

An Imhoff tank and activated sludge tank of the Simplex type has just been completed at Lawrence for the Haskell Indian Institute, providing treatment for the sewage of approximately 1200 persons. This was built under the supervision of Earnest Boyce, chief engineer of the State Board of Health, as special sanitary engineer for the Indian Field Survey. We expect to publish an article giving the operating results of this plant as soon as sufficient data have been recorded.

Some Data on New York's Water Supply

Forty-four reservoirs hold a year's supply, distributed through more than two hundred miles of tunnels and aqueducts and four hundred miles of pipe

From time to time description is given of additions to the water supply structures and plant of New York City, each generally remarkable for its size, cost or other superlative features. To describe all the units that enter into the enormous works which supply water for this six million people would require several volumes—which very few would ever read. It is therefore interesting to read a description of the works condensed to 28 pages, which forms a part of a report just made public by the National Board of Fire Underwriters. A still further condensed abstract from this may be of interest as giving a definite idea of the magnitude of the systems which supply the various boroughs of Greater New York.

In addition to the publicly owned supply there are several privately owned supplies, but these furnish only a comparatively small percentage of the total consumption.

Of the publicly owned supplies, the Croton yields about 336,000,000 gallons a day from a watershed of 375 square miles 18 miles from the city. The Catskill watershed, 72 miles from the city (including those of the Bronx and Byram rivers) totals 593 square miles, and furnishes an estimated dry-weather yield of 603,000,000 gallons a day; while wells and infiltration galleries in the Brooklyn supply can furnish 110,000,000 gallons a day, and others in Queens and Richmond boroughs 25,000,000 gallons. The consumption varies between 700 and 1100 million gallons a day through about 600,000 services.

The city uses 44 reservoirs and 7 standpipes, of which 35 are impounding or storage reservoirs from 199 to 1130 feet above tide water (except a few on Long Island); while the 9 distributing reservoirs have elevations between 119 and 295 feet, and the standpipes between 195 and 453 feet. The storage reservoirs have a combined capacity of 285,711 million gallons, or nearly a year's supply; while the combined capacity of the distributing reservoirs and standpipes is 3610 million gallons, or about four days' supply.

The Catskill system includes 92 miles of aqueduct, of which 55 miles is concrete of cut and cover type; 24 gravity tunnels have a combined length of 14 miles and 7 pressure tunnels a length of 17 miles (one tunnel being 1114 feet below sea level, to enable it to cross under the Hudson river through solid rock); while 6 miles is across deep valleys in siphons composed of three parallel lines of steel pipe 7.33 to 11.2 feet diameter, encased in concrete and lined with cement.

Water from this system is distributed through the city in a tunnel 18 miles long and 216 to 715 feet deep, which passes through Bronx, Manhattan and Brooklyn boroughs. At 21 shafts the water is brought through 48-in. to 72-in. risers, provided with pressure regulators and meters, to the distribution mains. From Brooklyn the supply is carried to Staten Island (Richmond borough) through 36-in. and 42-in. cast-iron pipes laid under the Narrows. A second distribution tunnel is now under construction, 17 feet diameter and 20 miles long, through the Bronx and Queens boroughs to Brooklyn.

The Croton supply is brought to the city through the new Croton aqueduct, consisting of 24 miles of gravity masonry conduit of 14 ft. diameter, 7 miles of 12 ft. pressure conduit, and 3 miles of twelve parallel lines of 48-in. pipe. A small part of the old Croton aqueduct, of masonry, 53 sq. ft. area, built in 1837 to 1842, is still in use.

The Ridgewood supply, from surface and underground sources on the southern slope of Long Island, is collected in two gravity masonry and one steel pressure conduit, which deliver it to the two Ridgewood pumping stations, which pump it to the low service. This supply is now retained largely as a reserve to supplement the Catskill supply, all equipment being kept in good condition. This system includes 11 ponds, 451 wells, and two infiltration galleries consisting of 29,500 feet of open-joint vitrified pipe.

In addition, there are 11 pumping stations in Brooklyn, Queens and Richmond boroughs, drawing direct from wells; some in constant use and others held in reserve.

In Manhattan borough there are four services—low, intermediate, high, and tower; in Bronx, Brooklyn and Richmond boroughs there are low, intermediate and high; and in Queens borough, low only. These are relative for each borough, the low in hilly Richmond being as high as the highest intermediate in Manhattan. The high in Manhattan and the Bronx are supplied by a reservoir with elevation of 295 feet; that in Brooklyn with a tower 275 feet; and in Richmond by a standpipe, elevation 453 feet. The total average consumption in 1928 by the several low services was 408.8 m.g.d.; the intermediate, 306.7 m.g.d.; the high, 116.9 m.g.d.; and the tower, 15.2 m.g.d.

The distribution system, on December 31, 1928, included 4,121.61 miles of cast-iron pipe from 4 to 60 inches diameter; and 42.89 miles of steel pipe, 12 to 72 inches diameter. Of the cast-iron pipe, 2.5% is 4-inch; 31% is 6-inch; 40.1% is 8-inch and 19.8% is 12-inch. No other size constitutes as much as 6%. In this system are 103,108 gate valves and 63,203 fire hydrants. Approximately 50% of these mains have been laid since 1905. At present nothing smaller than 12-inch is laid in congested sections, and generally 8-inch elsewhere.

Repair gangs make annual inspections of valves 20 inches and larger in diameter, but no attempt has been made regularly to inspect all valves. Hydrants are inspected by the fire department; during freezing weather daily inspections are made and hydrants found frozen receive immediate attention.

About 24% of the total number of services are metered, confined to commercial and industrial services. The consumption in 1928 was about 147 gallons per capita of resident population.

Preliminary Purification of Polluted Water*

By Lyle L. Jenne†

In this paper a comparison is made, on the basis of monthly results obtained over a period of three years at four Philadelphia filter plants, of the improvement in turbidity and bacterial content effected by long-time sedimentation as compared with short sedimentation and filtration in either slow or rapid sand filters.

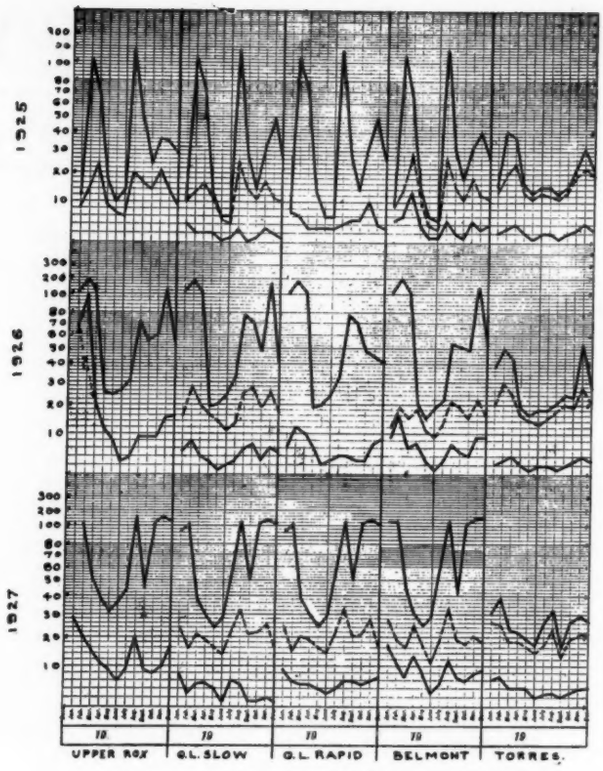


CHART 1—PRE-TREATMENT—TURBIDITY

THE water supply of Philadelphia is taken from the Delaware and Schuylkill rivers. The Delaware river has its rise in New York State and, flowing southward, forms the boundary line between Pennsylvania and New Jersey, with tributaries in each state. Its water shed above Philadelphia is about 7,860 square miles, with a minimum daily flow of 800,000,000 gallons. It furnishes about fifty-five per cent of the city's supply.

The Schuylkill river is entirely in the State of Pennsylvania, and flows into the Delaware just below the city. Its water shed above the city is 1,905 square miles, with a minimum daily flow somewhat less than 200,000,000 gallons. It furnishes the remainder of the city's supply.

Both of these sources carry a heavy pollution load, and this paper considers the results of the methods of preliminary treatment at the various filter plants. Results for the years 1925, '26 and '27 are used, as operating conditions were practically the same over this period. This pre-treatment will be considered with reference to turbidity, bacteria and coli index.

There are four filter plants, one on the Delaware and the others on the Schuylkill. The three Schuylkill plants are as follows:

Upper Roxborough—This plant has a sedimentation basin of one hundred and forty-seven million gallons capacity, and a theoretical storage period of 5.7 to 7.7 days during this three-year period. There is no other preliminary treatment, as this settled water goes directly to the slow sand filters.

Queen Lane—This plant has both a slow sand and rapid sand system. The sedimentation basin has a capacity of one hundred and seventy-seven million gallons. The theoretical storage period for the slow sand water was from 3.5 to 3.9 days, assuming no interference with the rapid sand water. However, the rapid sand water spills over the same flume, at the end of this basin and flows back across the end and out to the coagulation basins. Assuming both waters to occupy the whole of the sedimentation basin, as was probably the case, the theoretical storage period was 1.8 to 2.1 days. Some intermediate figure may be more correct for the slow sand water. The settled slow sand water then passes through the preliminary filters. The rapid sand water passes from the coagulation basins to the rapid sand filters.

Belmont Filters—This plant has a sedimentation basin of seventy-two million gallons with a theoretical storage period of 1.5 days. The settled water passed through the preliminary filters of coke breeze, thence to the slow sand filters.

Belmont and Queen Lane Intakes—Belmont and Queen Lane intakes are located along the pool formed by the Fairmount dam. This pool is approximately three miles long to the Queen Lane intake and six miles long to the Belmont intake. This exerts a marked influence on the raw water bacteria content and coli index at these two intakes, especially during the summer period of low flow. This might even be considered as an additional pre-treatment process at these two plants.

On the Delaware river is located the *Torresdale Filter Plant.* This plant has a sedimentation basin of one hundred million gallons, and two hundred million gallons at high tide, as this basin was designed to raise and fall with the tide. Therefore, the mean storage is about eighteen hours. The settled water passes through preliminary filters and then to the slow sand filters.

*Paper before American Society for Municipal Improvements.
†Sanitary engineer, Bureau of Water, Philadelphia, Pa.

TURBIDITY

The results of the pre-treatment processes will be considered in a general manner and tables of the supporting data will be appended, showing results on the monthly basis, which may be examined for more detailed study, rather than extend the body of the paper with the inclusion of such description. Chart No. 1 shows the monthly turbidities in parts per million on the raw and applied waters at the various plants. The Schuylkill plants are fairly comparable, one with each other, as they have similar river conditions; whereas the turbidity of the Delaware river never rises as high as the Schuylkill. Storm conditions are reflected at once by rising turbidity on the Schuylkill river, whereas it takes quite a severe storm to cause the turbidity on the Delaware to rise very high. Turbidity removal by plain sedimentation at Roxborough is not quite as effective as sedimentation and preliminary filtration at the other plants, although the partial sedimentation and coagulation of the rapid sand water at Queen Lane is about the same. Figures on Upper Roxborough for January and February, 1926, for the applied water ran much higher than the normal operation of the plant would warrant, because the sedimentation basin was out of service for several days and at a time when the turbidity was very high. A reduction in the average turbidity to about fourteen would probably be a reasonable figure for that year. This reduction was also less during

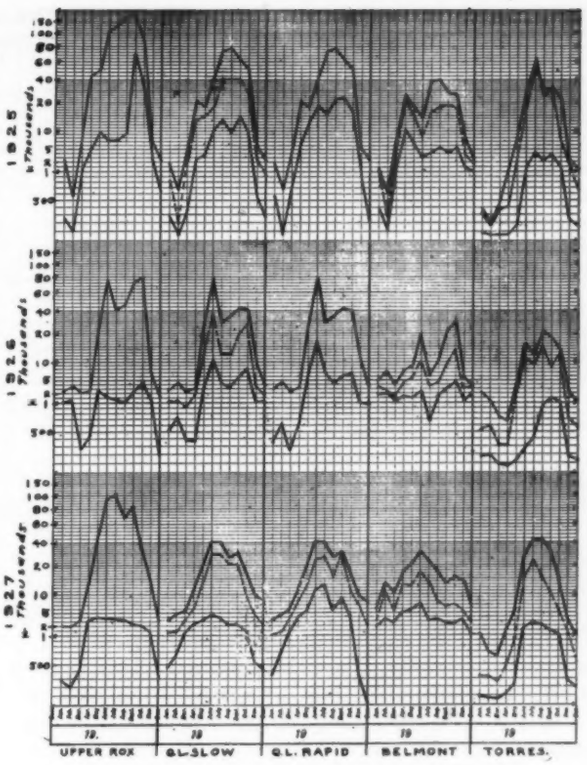


CHART 2—PRE-TREATMENT—BACTERIA

Results of Pretreatment at the Philadelphia Filter Plants

TURBIDITY

Annual averages at each of the filter plants for 1925, 1926 and 1927.

	1925				per cent removed		1926				per cent removed		1927				per cent removed	
	Raw	Sedimentation Basin	Per cent removed	Applied final	By presedimentation	From river	Raw	Sedimentation Basin	Per cent removed	Applied final	By presedimentation	From river	Raw	Sedimentation Basin	Per cent removed	Applied final	By presedimentation	From river
Queen Lane—																		
Rapid Sand	46	5*	89	..	..	..	74	5*	93	..	..	..	77	21†	73	6*	71	92
Slow Sand	46	12	74	2§	92	96	74	19	74	4§	79	95	77	21	73	4§	97	95
Belmont	47	14	70	4	71	92	69	16	77	6	62	91	85	20	76	9	55	89
Torresdale	21	16	24	2	88	90	29	20	31	4	80	86	25	19	24	4	79	84
Upper Roxborough	48	..	..	14	..	71	75	..	..	22	..	71	84	..	..	14	..	83

*Coagulation basin. †Head house gate. §Pre-filters partly by-passed.

BACTERIA

	1925				per cent removed		1926				per cent removed		1927				per cent removed	
	Raw	Sedimentation Basin	Per cent removed	Applied final	By presedimentation	From river	Raw	Sedimentation Basin	Per cent removed	Applied final	By presedimentation	From river	Raw	Sedimentation Basin	Per cent removed	Applied final	By presedimentation	From river
Queen Lane—																		
Rapid sand	30,400	10,000*	..	..	..	67	23,300	4,310*	..	.....	..	86	18,230	11,820†	..	4,680*	61*	74
Slow sand	30,400	16,700	45	5,470	67	82	23,300	11,000	53	3,300	70	86	18,230	12,040	34	2,000	83	89
Belmont	17,900	11,000	38	3,650	67	80	10,960	5,570	49	2,080	63	81	15,720	8,760	46	3,490	60	78
Torresdale	15,800	11,900	25	1,180	90	92	7,760	5,170	33	436	92	94	14,620	6,240	57	827	87	94
Upper Roxborough	66,300	.. ..	..	12,400	..	82	29,700	..	..	1,520	..	95	38,320	..	..	2,120	..	95

*Coagulation effluent. †Head house gate.

COLI INDEX

	1925			1926			1927		
	Raw	Applied Slow	Applied Rapid	Raw	Applied Slow	Applied Rapid	Raw	Applied Slow	Applied Rapid
Queen Lane	21,650	2,780	4,140	20,600	2,990	2,440	26,900	1,925	2,070
Belmont	10,600	2,060		14,900	2,470		17,400	2,480	
Torresdale	19,500	2,080		22,800	2,890		27,500	2,260	
Upper Roxborough	27,600	4,290		25,200	2,690		30,900	2,460	

Percent of Annual Removal by Pre-Treatment

Year	TURBIDITY River	Applied Finals	Percent Removed	BACTERIA River	Applied Finals	Percent Removed	COLI INDEX River	Applied Finals	Percent Removed
				Torresdale					
1925	21	2	90	15800	1180	92	19500	2080	89
1926	29	4	86	7760	436	94	22800	2890	87
1927	25	4	84	14620	827	94	27500	2260	92
AVERAGE			87			93			89
				Upper Roxborough					
†1925	48	14	71	66300	12400	82	27600 *(30500)	*4290	86
†1926	75	22	71	29700	1520	95	25200	2690	89
1927	84	14	83	38320	2120	95	30900	2460	92
AVERAGE			75			91			89
				Queen Lane (Slow Sand)					
1925	46	2	96	30400	5470	82	21650 *(22600)	*2780	88
1926	74	4	95	23300	3300	86	20600	2990	86
1927	77	4	95	18230	2000	83	26900	1925	93
AVERAGE			95			86			89
				Queen Lane (Rapid Sand)					
1925	46	5	89	30400	10000	67	21650 *(22600)	*4140	82
1926	74	5	93	23300	4310	86	20600	2440	88
1927	77	6	92	18200	4680	74	26900	2070	92
AVERAGE			91			76			87
				Belmont					
1925	47	4	92	17900	3650	80	10600 *(13200)	2060	84
1926	69	6	91	10960	2080	81	14900	2470	83
1927	85	9	89	15720	3490	78	17400	2480	86
AVERAGE			91			80			84

†Half this basin out of service last four months of 1925, and only about half capacity used first three months of 1926.
*Started April 1st.

the last four months of 1925, because one of the basins, or half the capacity, was out of service.

For the same applied water at Torresdale, the reduction of the turbidity is a smaller per cent, because the raw turbidity is lower. Coagulation is only resorted to in the sedimentation basins during storm periods, i.e. on a rising turbidity of fifty, and is continued until the turbidity reaches that point on its recession. Obviously it would be possible to increase the removal of turbidity in the sedimentation basins by using alum a greater percentage of the time.

In the turbidity tables for 1927 at Queen Lane it will be noted that there is a column called the "head house gate" on the rapid sand system. This is the effluent at the inlet end of the basin, and goes to the coagulation basins. These results are approximately the same, and the average is the same, as the main effluent of the sedimentation basin at the other end flowing to the pre-filters. This would indicate that the sedimentation period should be considered at about two days, assuming both the rapid and slow sand water to occupy the entire basin, as the rapid sand water apparently goes back up along the side of the basin to the head house gate, where it flows to the coagulation basins. This year it is possible to make a direct comparison between the per cent removal by the pre-filters and a coagulation period of about four hours; the removal by the pre-filters being 97 per cent, and by coagulation 71 per cent.

BACTERIA

Chart No. 2 shows similar results for bacteria per c.c. on Agar, 37°, 24 hours. Here it will be seen that plain sedimentation at Roxborough is the most effective of the pre-treatment methods on the Schuylkill water. The results, and the per cent removal, for 1925 would have been considerably better and comparable with the results of the other two years had not one of the basins been out of service for the last four months. It would be fair to assume an average removal of 95 per cent for this plant, which would make this the most efficient pre-treatment process for the removal of bacteria. At Queen Lane, bacteria results bear out the turbidity results in showing that, although the rapid sand water is taken out at the inlet end of the basin, it evidently has the same length of sedimentation as the slow sand water, which is taken out at the other end of the basin.

COLI INDEX

(B. Coli Group per 100 c.c)—Here there is very little choice between the results of the various processes, as there is only a range of five per cent difference between the percentages of removal, which range from 84 to 89. However, with the full period of sedimentation at Roxborough for the last four

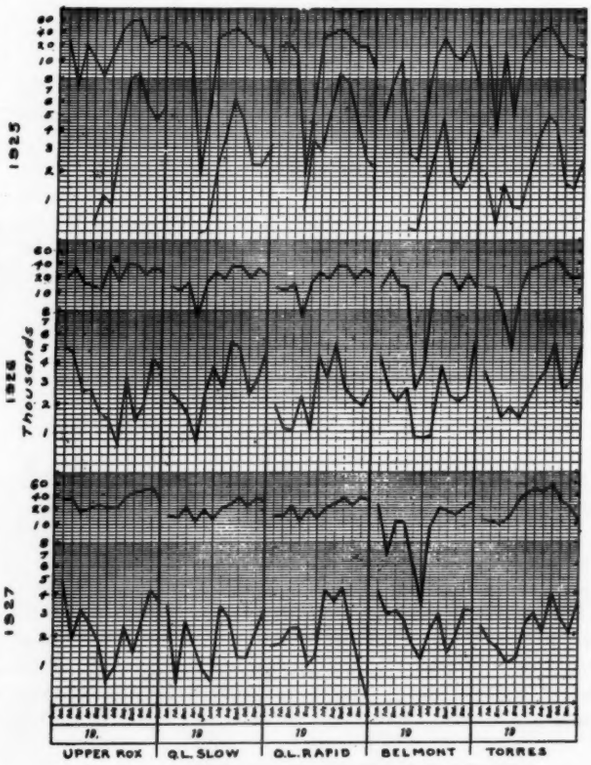


CHART 3—PRE-TREATMENT—COLI INDEX

months of 1925 and the first two of 1926, the per cent removal would probably be about 90, which is slightly better than at the other plants.

Pre-chlorination was started on the rapid sand water at Queen Lane in November 1927. This accounts for the sudden drop in the Coli Index at that time shown on Chart No. 3.

SUMMARY

In turbidity removal, short sedimentation with preliminary filtration or with after-coagulation is found to be the most efficient method of preliminary treatment, although a sedimentation period of approximately a week, using a coagulant with turbidities somewhat under fifty, would be expected to produce the same results. From the bacteria standpoint, plain sedimentation with a storage period of about a week is more effective in removing bacteria than a short sedimentation period with pre-filtration, even using those of a mechanical type. However, as part of the time the pre-filters at Queen Lane were not in the best of condition, it might be assumed that these two processes would be about equal in value. This is borne out also by the Torresdale filters, where, although the raw water had a lower content, the per cent removal was larger. The Roxborough figures, as mentioned above, would be larger had it had the advantage of its full sedimentation period throughout the entire period. As to coli index, a sedimentation period of a week would be better than the combination of short sedimentation with mechanical pre-filtration.

CONCLUSIONS

All things considered, the writer believes that where possible the best method of pre-treatment of polluted water is plain sedimentation with a storage period of a week or more, using a coagulant for turbidities over fifty, or possibly starting the coagulation at a lower point if conditions warrant.

Another advantage is the dissipation of almost all of any taste and odor that may be present in the raw water; although we have no quantitative data to support this conclusion.

This method, except for storm periods, requires practically no attention.

The objection in the case of large installations is the area required.

The advantage of the short sedimentation and preliminary filtration is conservation of space. The objections are the dependence upon a mechanical installation for operating and cleaning, and the requirement for constant operating attendance.

This system has much less value in the removal of taste and odor.

Specifications for Short Cast-Iron Pipe Fittings

Since last Spring, the Sectional Committee of the American Water Works Association on specifications for Cast Iron Pipe and Special Castings has taken up in earnest the possibility of preparing standard specifications for cast-iron pipe fittings of shorter dimensions than the present A. W. W. A. standards. Some large cities, notably Detroit and Los Angeles, use all short fittings made to their own standards. Quite a few other cities use Grinnell and other short fittings which are used to quite an extent. Whether the use of shorter fittings is most economical and desirable or not, the situation is that there are available on the market short fittings of a large number of kinds without the advantages of interchangeability. The Sectional Committee is considering the possibility of standards for short fittings which would have dimensions in general about average as among the various short fittings in greatest present use, and approximating rather closely the dimension of the present A. S. M. E. standards for flanged fittings. If these standards for short fittings are eventually adopted, they will be intended not to replace the present long A. W. W. A. fittings but to give the purchaser a choice of long or short.

The Sectional Committee is having tests made of both short fittings made according to these proposed dimensions, and also of the present A. W. W. A. fittings as follows:

1. Tests on friction loss through fittings are being made at Cornell University, Ithaca, N. Y., under the direction of E. W. Schoder, professor of experimental hydraulics. Friction loss tests are being made on four kinds of fittings, namely, crosses, tees, quarter bends and eighth bends, both long and short, and both 12-inch and 6-inch, making sixteen kinds of fittings to be tested. Friction loss tests on the cross will be made with water issuing from all the possible combinations of 1, 2 or 3 outlets, and similarly for the tee. The velocities at entrance will probably range between 3 and 10 feet per second.

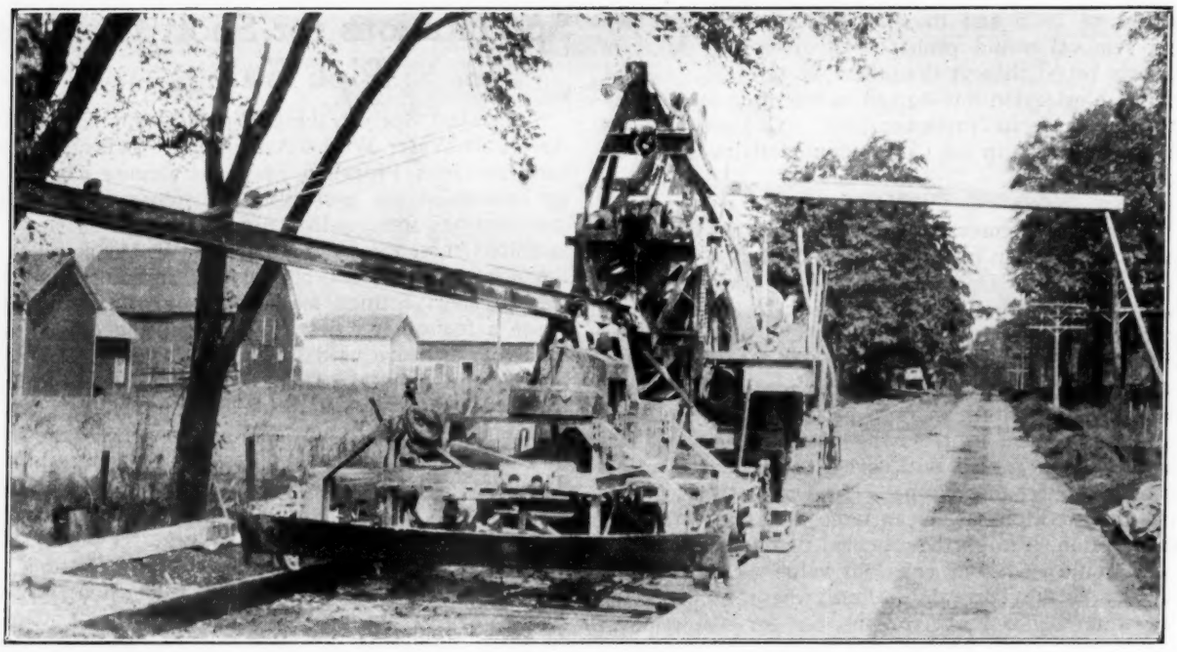
2. Tests of the same kinds of fittings to destruction by bursting are being made at the University of Illinois, Urbana, Ill., under the direction of M. L. Enger, professor of mechanics and hydraulics.

The carrying out of these tests has involved the invention of new methods of holding the end bulkheads and measuring the amount of expansion of the fitting under test.

Pretreatment-Turbidity (Sample of tables prepared for each of the plants)
Upper Roxborough Plant

	1925			1926			1927		
	Raw	Applied Finals	Per Cent Removed	Raw	Applied Finals	Per Cent Removed	Raw	Applied Finals	Per Cent Removed
Jan.	12	8	33	110	*66	40	112	28	75
Feb.	108	15	86	188	*99	47	116	20	83
Mar.	67	24	64	118	21	82	52	15	71
Apr.	18	9	50	25	12	52	38	11	71
May	10	7	30	24	8	67	32	9	72
June	14	6	57	26	3	88	36	6	83
July	180	20	89	31	4	87	44	9	80
Aug.	47	16	66	71	9	87	147	20	86
Sept.	24	14	42	56	9	84	45	9	80
Oct.	36	21	42	60	9	85	111	8	93
Nov.	35	14	60	136	15	89	152	10	93
Dec.	29	9	69	56	16	71	129	16	88
Average	48	14	..	75	22	..	84	14	..
Percent removal for the year	..	..	71	..	..	71	..	..	83

*Sedimentation Basin out during part of Jan. & Feb.



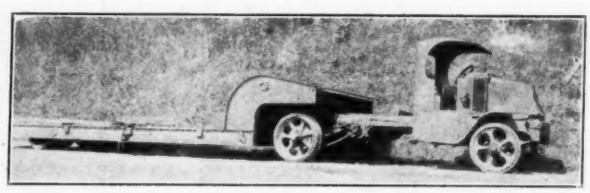
LAKEWOOD SCREED IN FRONT OF MULTI-FOOTE MIXER

A New York State Concrete Highway Job

Good results secured by carefully selected equipment and few men but these the best obtainable

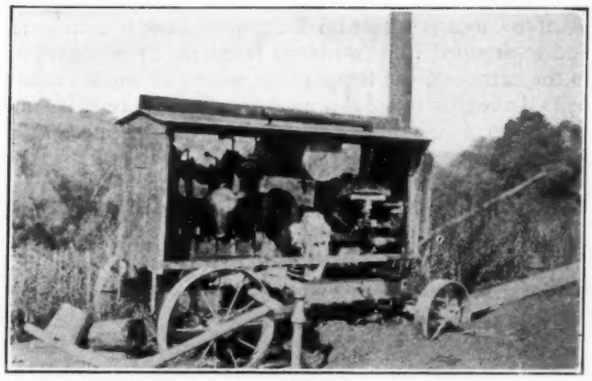
Economy in the use of men and the employment of conservative methods of construction are illustrated in the building of a concrete pavement between Florida and Warwick, N. Y. by the L. C. Carchia Co., of Boston, Mass. This job involves the laying of 4.6 miles of 18-foot, two-lane, concrete highway, along a section of Route 55, and the handling of about 45,000 cubic yards of unclassified excavation. The concrete is 8 inches thick at the sides and 7 inches at the center; standard mesh Truscon reinforcement is used; the mix is 1:2:3½. Servicised expansion joints are placed 78½ feet apart. The contract price was approximately $216,000. The work was finished ahead of the time allowed by the contract.

Said M. A. Carchia, who is in charge of the work: "There were a couple of rock cuts where we had to do considerable heavy work, but for the most part the excavation and grading part of the work were not very difficult. We used Ingersoll-Rand drills and Ingersoll-Rand and Sullivan compressors—one of each—on this work, and handled the blasted rock with a Marion steam shovel with a ¾-yard bucket. It did well on this tough work. It loaded into our big Macks, which hauled the material out for fills. These handled around 5 yards at a load, and sure moved rock and dirt. The earth excavation we handled with a gasoline-driven Northwest, tractor mounted. We couldn't use the big Macks for hauling after the concrete was laid, because the state engineers said the wheel load was too heavy, but we have some baby Macks—only 5 tons capacity—which we are using for hauling batches."

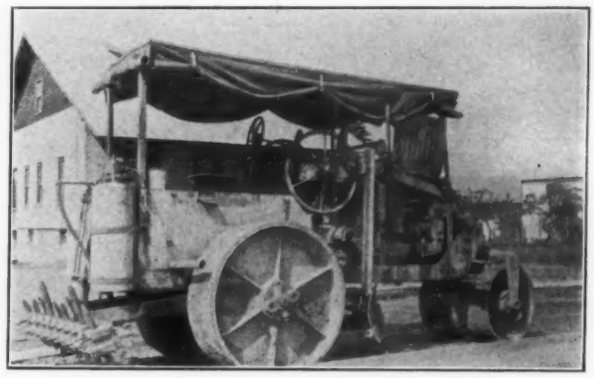


7½ TON MACK TRUCK AND ROGERS TRAILER FOR TRANSPORTING HEAVY EQUIPMENT

"Our men are good," continued Mr. Carchia, "and many of them have been with us a long time. We pay them right, and they will do far more work than the average. We keep four to six men on the fine grading gang, giving them a light Acme roller along with the regular hand tools, and they keep out ahead. We use Metaforms, and four men handle all the form setting. On our mixing and finishing gangs, we use only 13 men. We don't want them stepping over each other on the job, and we believe in fewer and better men, so we get good men and pay them. Two men handle all the spading, there are 2 spreaders, 1 cement man (opening sacks on the batch trucks), 2 men handling steel, and one man on joints. With the operator, this makes 9 men. There are 4 more on the Lakewood screed, brooming and finishing, and these do the complete job of finishing up the pavement. When the subgrade is too wet to



C. H. & E. TRIPLEX PUMP
Used three years on a number of jobs with no repairs.



ACME ROLLER USED ON FINE GRADING

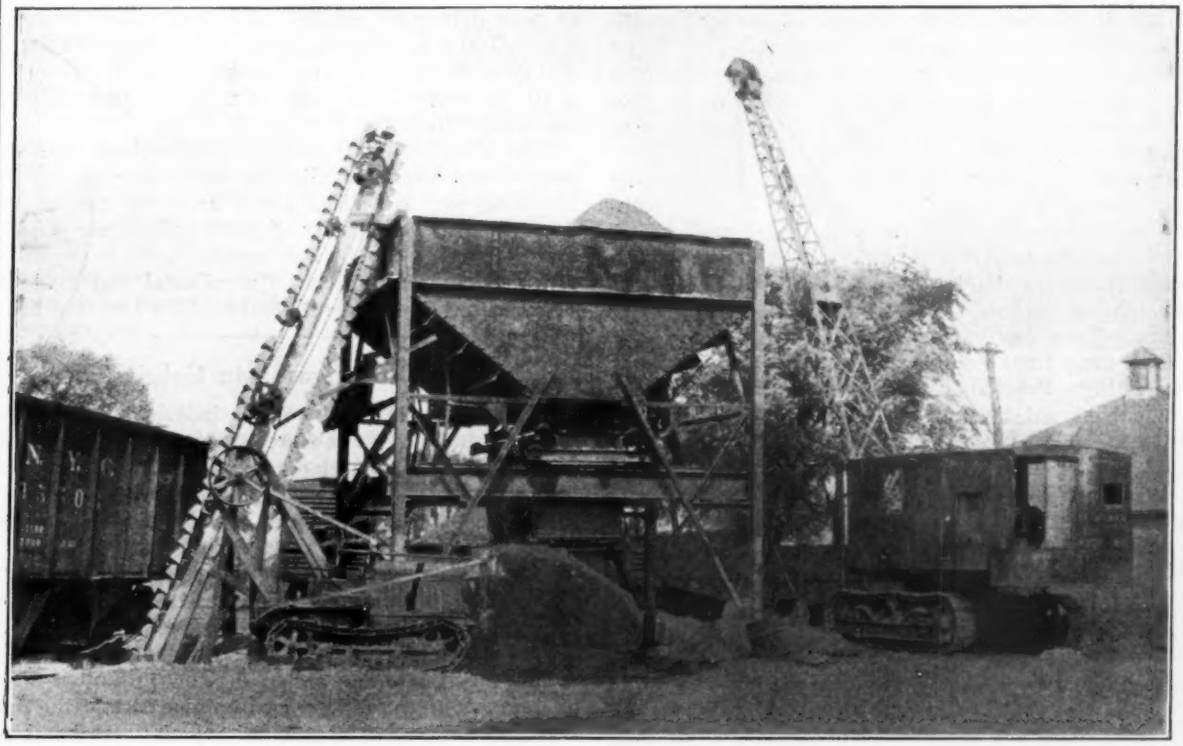
place concrete, we use as many of the men as possible on shoulders or cleaning up the work.

We use a Multi-Foote paver, a 27E, and are running 6-bag batches. We put out a pretty steady average of around 1600 feet of single lane road a day, and rarely fall below 1200 feet.

"We use two of our own trucks—the baby Macks—and hire as many others as are required to haul the batched aggregate from our stock yard at Florida, three six-bag batches to a truck. Now that the job is about finished, the haul is short, but at the beginning it ran up to about 6 miles. Our average of hired trucks has been about 6, and these we got without trouble locally. The bodies on our trucks are built by the International Motor Truck Co., with Heil hoists."

On a nearby job, the Lane Construction Corp. is operating its own quarry and sand screening plant; but Mr. Carchia says: "We usually find it just as desirable to ship in our stone, as it is one less thing to look after. Our aggregate comes to us at Florida, where we have an Erie Aggremeter bin set up. We have another Northwest crane there, with a ¾-yard clamshell, which handles the sand. This loads either into the Erie bin, or onto a stockpile. The stone is dumped from the battleship cars into a small pit, and we set up a belt conveyor to take this up into the bin. For power, we rigged up a belt on the power take-off of a little Cletrac "20" tractor we had, and it works fine.

"The summer has been dry and water has been something of a problem. On the Warwick end of the job, we dammed up a little stream and pumped that dry finally. Now we have tied onto the Florida water system, which ends at the Florida end of our job.



ERIE AGGREMETER BIN BEING FILLED WITH BELT CONVEYOR OPERATED BY CLETRAC TRACTOR AND WITH NORTHWEST CRANE

LINN TRACTOR USED FOR HAULING

The pressure isn't quite enough to take the necessary water through 4 miles of 2-inch line, so we hitched our C. H. & E triplex on it. And by the way, we have used this particular pump for more than three years on road work and haven't spent ten cents on it yet. Our hose outlets we space 300 feet apart, as our mixer hose is about 150 feet long."

After brooming and finishing, the concrete is protected temporarily with burlap, and then cured with hay. The road is opened to traffic in 15 days. Traffic control on the one-way section is maintained in the meantime by means of two flagmen provided with telephone connection, wires being laid alongside of the road. With the rather light traffic using this section of the road, this system is very satisfactory and results in but little delay.

Gravel Plant With Capacity of Twelve Hundred Tons An Hour

One of the most modern gravel plants in Canada is located at Sarnia, Ontario. The material produced at this plant is handled entirely by machinery operated by hydro-electric power, with the exception of two steam locomotives which transport the material from the pits to the plant.

Power is delivered by means of a 26,400 volt line and is supplied to the plant through a small sub-station consisting of three 250 kv-a. transformers which step the voltage down to 575 volts. Two 550 volt feeder panels and oil breakers take care of the two low tension feeders, one for the plant and one for operating the loading apparatus for boats.

The drag lines used at this plant are particularly interesting. Previously, a steam drag line, carrying a 3 cubic yard bucket, was used, but it was found that an electric drag line carrying a 1½ cubic yard bucket could do as much work in the same time, owing to greater speed and steadier operation. There are two of these drag lines now in operation at this plant. These drag lines are operated by 250 volt, d.c. motors supplied by means of a 50 kw. motor generator set. The motor used for raising the bucket is rated at 75 h.p. and the one used to pivot the machine is rated at 30 h.p. These machines pull 100 per cent overload for a period of five seconds during the loading of the bucket and are operated at more than three thousand feet from the sub-station, power being transmitted to them over a line consisting of 250,000 and 500,000 circular mil cable.

The material is transported from the pits to the plant by means of steam locomotives and dump cars, and is dumped into two large hoppers. It is conveyed to the centre of the hoppers by means of small rubber belts driven by two 5 h.p. motors. From here it is conveyed up a steep incline to the plant hopper, at a height of approximately 75 feet, by means of a large belt conveyor driven by a 50 h.p. motor. It is transferred from here to the screen by means of a short belt driven by a 5 h.p. motor. The screen is driven by a 75 h.p. motor which also drives another similar screen when the plant is operating at full capacity. The material is forced through the screens by hydraulic pressure, the water being forced up a six inch pipe by means of a rotary pump driven by a 50 h.p. motor.

The material is then washed, screened and graded and comes to rest in large bins, and from here it is transferred to the storage pile by a series of two belts driven by 50 and 100 h.p. motors respectively. The method of dumping the material on the storage pile at any desired point, depending on grade of material, is interesting. The belt is looped into an S shape by means of rollers in a movable hopper. Thus the material is on the belt at the top of the S, but falls into the hopper when the belt turns downward and is diverted to the storage pile through the hopper. This mechanism may be moved to any desired point above the storage pile on tracks placed there for the purpose.

Underneath the storage pile is a concrete tunnel, in the roof of which, at regular intervals, are gates which may be opened to allow the material to flow through on to a conveyor belt some 300 feet in length and 30 inches in width. In order to load a boat, the gate under the desired grade of material is opened and the material drops onto the moving belt, and is conveyed to the boat (about half a mile away) by a series of belts driven by motors varying in power from 50 h.p. to 100 h.p. The final belt which drops the material into the boats is on a movable shuttle, driven by a 10 h.p. motor, and may be moved considerably to reach any particular boat.

The wharf itself is about 1100 feet long, and the main pump, which supplies the water for washing the material, etc., is located about half way out on the wharf and has a capacity of 1900 gallons per minute, and is driven by a 100 h.p. motor.

This plant can produce the material and load the boats at the rate of from 1000 to 1200 tons per hour.

Engineers to Investigate San Gabriel Dam Site

Nine engineers are to make individual reports as to the suitability of the present site for the building of the San Gabriel dam near Los Angeles, Calif. Work on the dam, the excavation for which had been nearly completed, has been halted following a land slide which disclosed that the character of the rock in the vicinity of the site was unsuitable.

Surveys following the slide indicated that the site is crossed by several faults. Two exploration tunnels which were subsequently dug to a depth of 150 feet below the stream bed failed to show unfaulted rock of high strength, and general opinion is that the dam will not be erected at the present site. It has been suggested that a number of lower dams along the canyon would store the same amount of water, and with greater safety.

ASPHALT MIXING PLANT, WHICH HAS GIVEN FOURTEEN YEARS GOOD SERVICE

Asphalt Resurfacing in Hornell

Resurfacing old brick streets with asphalt has been tried out and found economical and successful in Hornell, N. Y. The city, through F. H. Robinson, city engineer, has resurfaced 75,000 square yards of pavement during 1928 and 1929, and along with this work has widened and modernized the streets. The brick pavements which were resurfaced have served for 30 to 40 years but have in recent years become rather rough. The average cost for surfacing alone has been in the neighborhood of $1 per square yard, but the widening costs, including new curbs and other appurtenances, have brought the cost for 45,000 yards of paving in 1929 to a total of $75,000.

In preparing the streets for resurfacing, they are widened so as to give a 66-foot pavement where possible. To accomplish this, the sidewalks have been narrowed from 20 feet to 17 feet, and a new concrete curb constructed. On Loder street, which was widened from 30 to 37 feet, all the additional width was secured on one side, which necessitated moving the crown. This was accomplished by shaping up with the binder course.

On the work this year, a binder and top course, each 1½-inch thick, is laid. The pavement is cut out around manholes and other appurtenances, with an Ingersoll-Rand portable compressor mounted on a trailer, and an I-R pavement breaker, corner radii are increased, and the street is carefully swept. Bad holes, of which there are relatively few, are filled with concrete, and lesser depressions are leveled up with excess binder. Hot stuff is dumped on the old pavement, spread by a gang with shovels and rakes, and rolled with an Erie roller. Ford trucks are used for hauling the material from the mixer to the job, each of the five trucks normally carrying 2-ton loads.

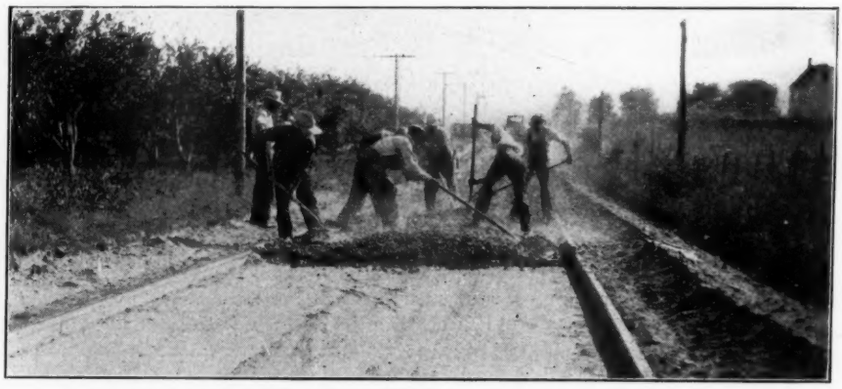
The asphalt is mixed in a Hetherington & Bernor railroad plant, which has been in use since 1915. This plant has averaged 750 yards a day since the job started, including all time lost due to shut-downs, bad weather and other causes. Texas asphalt is used. Sand and gravel are hauled in trucks to the plant, and handled there by an Erie crane with clamshell bucket. The sand is an unwashed bank sand, while the gravel is washed.

The Pittsburgh Testing Laboratory has the inspection work for the city, and is represented at the asphalt plant by H. W. Gilliard. The work is being done by Mayer Bros., Erie, Pa.

SPREADING HOT STUFF ON PREPARED PAVEMENT

ROLLING THE ASPHALT SURFACE

SHAPING THE ROAD TO THE DESIRED CROSS-SECTION



COARSE SLAG BEING SPREAD IN THE SLIDING FORMS

SLIDING FORMS FOR FINE SLAG BEING MOVED AHEAD

FINE SLAG BEING SPREAD BY TRUCK AND LEVELED

Building Low-Cost Roads in Sussex

THE road selected or decided upon to be improved by building a "lowcost" Farm-to-Market road is graded wholly by the use of machinery. A large track-laying caterpillar tractor and twelve-foot blade grader combination is used to shape the road to the desired cross section. The land in Sussex county is very flat and it is necessary to make only small fills. The shaping of the road usually costs from fifty dollars to one hundred and fifty dollars per mile.

After shaping, the road is allowed to compact or settle for a period of from six weeks to two months, at the end of which time the road is opened or trenched for the traffic-bound slag surface. The trenching is usually done by the use of a one-man grader outfit. The cost of trenching is usually about ten dollars per mile. For a ten-foot slag road the trench is usually made about 12 feet wide. This county has invariably used the trench method of building slag roads and has not as yet had a single failure.

There are two operations to the laying of slag for a traffic-bound slag road. First, a four-inch layer of large ¾-inch slag is placed on the subgrade. This is confined by a sliding form, built of several three-quarter to four-quarter by 4-inch rough pine boards

SLIDING FORMS FOR COARSE SLAG BEING MOVED AHEAD

FRESH SLAG ROAD BEING LEVELED FOR THE FIRST TIME

Farm-to-Market County, Delaware

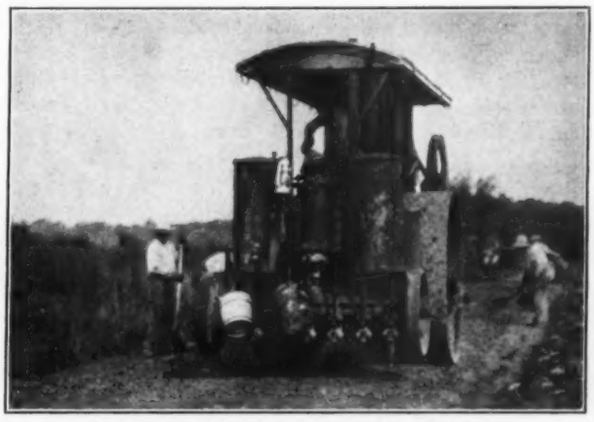
By R. C. Hill*

joined end to end to make two side forms about thirty feet long, with a cross piece or spreader connecting the forward ends which is set in so as to lie flat on the subgrade. Two ropes are attached to the end, to pull the sliding form forward. Three lining poles are used to sight by, properly to line up the sliding form. Once the form is set, dirt is pulled in to the outer sides, and a shovel of slag is placed at intervals on the inside of the form to prevent the form from closing due to the pressure of the dirt on the back. The trucks dump directly into the forms and the slag is spread by hand, filling the forms level full. When the forms have been filled level for their entire length, they are pulled forward for their length and the slag spreading repeated.

After the four-inch layer of ¾-inch slag has been laid for the length of the whole road, we start back where we first put down the ¾-inch slag and put on a two-inch layer of slag sand. First, the four-inch layer of ¾-inch slag is leveled by means of a home-made wooden drag. Then a sliding form is used, similar to the one used for the coarse slag, except that it is only two inches high.

After the ¾-inch slag has received a two-inch layer of slag sand, traffic does the compacting. During this compacting the road is gone over very frequently with a drag made of twelve-foot lengths of 2 x 4's. The frequency of the dragging of the road

*County engineer of Sussex county Delaware, and a director of the County Highway Officials' Division, American Road Builders' Association.



APPLYING CHIPS AND ROLLING

AT LEFT, HANDLING SLAG AT UNLOADING POINT. THE BIN IS PORTABLE AND CAN BE LOADED INTACT. AT RIGHT, HOW BITUMINOUS MATERIAL IS HEATED BY A PORTABLE OUTFIT

depends upon the traffic using it. The slag must be kept leveled until it compacts or sets up. The length of time necessary for this varies, being dependent upon the amount and kind of traffic, but is usually from three to nine months. The traffic binds the slag road in from the bottom to the top and does the job about a hundred per cent better than a roller of any description.

After the surface of the road becomes real hard, it is swept free of all dust and a dual surface treatment is applied, each of ¼ gallon of good, penetrating bituminous material. About 35 pounds of slag chips per square yard of surface is used to cover the bituminous material used, 20 pounds after the prime coat and 15 pounds after the seal coat. After each application of chips, the road is rolled by using a ten-ton roller.

A traffic-bound slag road built to a width of 10 feet costs about $2500 to $2600 per mile for the slag and the spreading of the slag. The hauling cost varies from $200 to $500 per mile. The surface treatment costs about $1000 per mile.

The frequency of subsequent resurface treatments depends entirely upon the kind and amount of traffic that uses the road. Sometimes it is possible to skip a year between the surface treatment and the resurface treatment; then again, it is necessary to resurface the treated road the following year. This is also true with the second resurface treatment of the road.

LOW-COST FARM-TO-MARKET ROAD AFTER TWO YEARS OF USE

Decreasing Cost of Electric Power

A few things have not increased in cost since "before the war," and among these is electric current. In fact, the cost today is very much less than it was fifteen years ago. Probably in Ontario, where the publicly owned hydro-electric power plants furnish current for the entire province, the decrease has been greater than the average for the United States; but in this country the decrease has been remarkable.

In Ontario, current for domestic service costs 5.08 cts. per kw.h. in 1914 and 1.71 cts. in 1928. If the latter be reduced to pre-war money value it would be about 1.04 cts., or about one-fifth the cost in 1914. For commercial lighting service the cost has been reduced much less—from 4.00 cts. in 1914 to 2.32 cts. in 1928. (The cost became greater than for domestic service in 1923.) The several rates in 1928 were: Domestic, 1.71 cts.; commercial lighting, 2.32 cts.; commercial power, 0.57 cts.; municipal power, 0.91 cts.; street lighting, 2.27 cts.

Meantime the average domestic consumption per consumer has increased from 21.0 kw.h. in 1914 to 115.5 in 1928, and the total domestic consumption from 14,000,000 kw.h. to 551,000,000. Current for commercial lighting increased from 15.7 million kw.h. to 68,000,000; or from 90.8 kw.h. per consumer to 287.4

Field Testing for Transverse Strength of Pavement Slabs

Obtaining beams and slabs for testing which have been placed and cured under same conditions as pavement

By W. C. Hammatt*

Laboratory testing of concrete mixtures for pavements has reached a high degree of perfection, but unfortunately there is little assurance that the laboratory tests are an accurate measure of the pavement strength. Certain things enter into the construction which may materially change the strength and endurance of the concrete slab from that designed or that expected from the laboratory investigation. The usual field tests consist of cylinders cast alongside the pavement, hand rodded and cured under different conditions than is the pavement concrete. Occasionally beams are cast in separate forms adjacent to the pavement and later tested for modulus of rupture. These, also, are cast and cured under different conditions than the pavement slab. Cores drilled from the pavement and tested for crushing strength give neither a measure of the resistance of the pavement to crushing forces, nor an index to the actual capability of the slab to withstand the load. No measure of actual crushing strength is given, since the failure of the core is by lateral disintegration, whereas this is impossible in the slab itself. Moreover, failure of a pavement never occurs from direct crushing.

Cracks in concrete pavements are the result of tension in one of the faces of the slab. This tension may be produced by traffic load, subgrade settlement, shrinkage, or even resistance of subgrade friction to temperature contraction. Hair cracks, often caused by rapid air drying or soil absorption, tend to weaken the slab against tensile stresses. Cracks are injurious in many ways: they destroy the appearance of the pavement; by breaking it into smaller slabs they destroy its stability; they allow water to reach and soften the subgrade; they form a starting point for progessive disintegration.

The above shows the value of a knowledge of the tensile strength of the pavement, and particularly of the tensile strength of its top and bottom faces, or, more to the point, the moduli of rupture with tension respectively in top and bottom faces. This can be obtained only by testing specimens taken from the pavement itself, placed and cured under the same conditions as the pavement as a whole. The difficulty of obtaining such samples has heretofore been a bar to this class of testing, and it has generally been considered that crushing tests of drilled cores gives an index to the transverse strength of the pavement itself, by applying the ratio obtained by comparison of laboratory or field cylinders and beams. The fallacy of this idea should be apparent, but it was demonstrated in a series of tests made on the California State Highway in the summer of 1928. Sections of the pavement were placed on the earth subgrade by their standard method, alternating with corresponding sections in which the subgrade was covered by a waterproof membrane before the concrete was placed (the Monolite process). All sections were cured in the same manner by ponding for six days. The expected ratio of modulus of rupture to crushing strength was .200. The ratio of modulus of rupture of beams to cores drilled from the same slab with the tension in the bottom of the beam was .174 for the standard pavement, but was .198 for the Monolite pavement, which has for its object the increase of density and strength in the bottom of the slab.

*President, The Monolite Company of America, San Francisco.

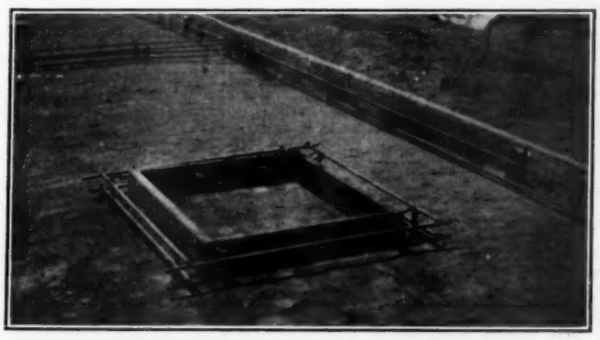


FIG. 1—FORM USED FOR MAKING TEST SLABS

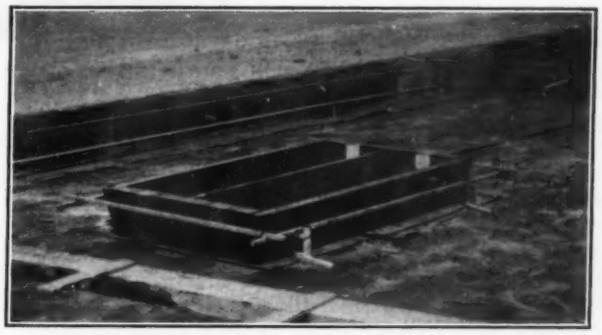


FIG. 2—KNOCK-DOWN FORM FOR BEAMS

For the purpose of facilitating the removal of beam sections from pavements for the purpose of flexural tests, the writer devised a form which could be cast in the pavement, the beams being subjected to all conditions obtaining for the pavement as a whole. This was first used on the tests above referred to, the form being of 1½-inch lumber and enclosing a slab sufficient in size to allow it to be sawed into three beams 10 inches wide by 34 inches long. At the proper age the wooden forms were chiseled out, allowing the slab to be lifted out. One of these forms is shown in place in Fig. 1. The writer has also had constructed some knock-down forms casting individual beams, which can be lifted out of the pavement with the beams at the proper age. Fig. 2 shows one of these beams in place on a job in Southern California.

The top of the form is set one quarter inch below the template of the pavement surface, permitting the screed of the finishing machine to pass clear. The bucket of the mixer is dumped directly over the beam form, entirely covering and filling it, and no hand tamping or spading is done, thus avoiding any condition different from that to which the rest of the pavement was subjected. The forms were well oiled and protected against moisture absorption before being put in place on the subgrade.

SHOWING BOND WHERE CENTER JOINT IS MADE. ALSO TOOLS USED (BY THE TWO MEN AT THE RIGHT) TO CORRECT ANY IRREGULARITIES LEFT BY THE LUTERS

The use of beam forms of this nature permits the taking and testing of samples of the pavement in such a manner as to give a much better measure of the pavement value than is done by the methods in general use. Moreover, the expense of obtaining and testing the samples is no greater than, if as great as, that of drilling pavement cores.

Widening and Resurfacing Old Road Without Detouring Traffic

By B. G. Etchison*

The West Virginia Road Commission solved a difficult traffic problem this fall when it commenced reconstruction, resurfacing and widening approximately eight miles on U. S. Route No. 60 east of Charleston, from Belle to Cedar Grove, West Virginia.

This road carries all traffic going east from Charleston through a thickly populated industrial section. During the peak traffic hour 400 to 500 vehicles pass over this road. No detours being available, it was necessary to take care of the traffic at all times. To effect this, one-half the road base and curb was constructed first for a distance of four miles; then the other half was completed. In the meantime, traffic was shifted from side to side, going in alternate directions.

The questions involved were:

How to direct traffic?
What kind of base material?
What kind of wearing surface?

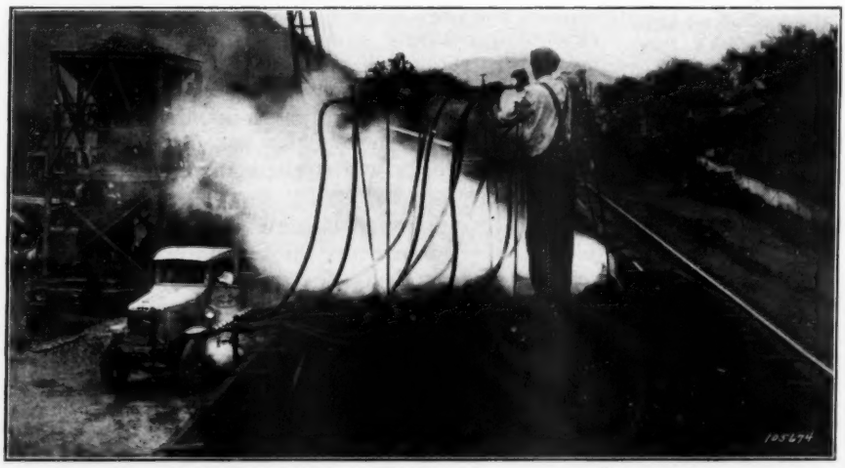
These questions were worked out by the division engineer by placing road police at intervals to direct traffic in alternate use of the single lane; penetration macadam and stone base were used to strengthen and correct grade variations, and elevate curves; and Kentucky rock asphalt was used as a surfacing material.

The old road was irregular, full of inequalities, with an excessive crown, and was not originally built to any uniform profile. It was sixteen feet wide, built of penetration macadam with several surface treatments of asphalt. The new plans called for widening to twenty feet with a concrete base and an 8-inch integral curb 1 foot high; a new penetration macadam base where needed to conform with new line and grade and cross sections, and surfacing with Kyrock.

The concrete base and north curb were built first, followed by placing on the north half of the base the necessary penetration macadam. Traffic used this half while the other curb and base were being built.

The Kyrock for the surface was steamed with jets, using steam at 90 pounds pressure, unloaded with a clamshell bucket and hauled to the job in two three-ton trucks. The loads were dumped into four piles and shoveled into place by five shovelers. Then the material was spread by three men using 2½-inch triangular lutes on steel strips laid on the penetrated base. Immediately following was a man using a 4-inch x 4-inch float eight feet long with ten-foot handle. This float corrected all irregularities of the triangular lutes. The surface was immediately rolled and opened to traffic.

*Division Engineer, West Virginia State Road Department



HEATING ROCK ASPHALT SURFACING MATERIAL IN CAR

Steam from boiler feeds eight ½-inch steam jets at each end of car through ¾-inch steam hose, with a valve controlling each jet. Jet pipes, five feet long, are inserted by opening valve wide (first wrapping piece of burlap sack around lower end of jet to guard operator from burns). In a few seconds jet can be pushed to bottom of car, when it is withdrawn about 12 inches to permit condensed steam to escape through floor of car. Jets are moved at intervals until whole mass is heated to 175° to 200°; requiring 2½ to 3 hours for a 50-ton car with air at 32°.

One interesting feature in laying this surface material was the absence of a construction joint in the center of the road where the two halves of the road were bonded. When the first half of the road had been spread and floated, the roller rolled up to within eight or ten inches of the center joint, thereby leaving a strip of loose surface material. After the laying crew had put down the last half, the center was rolled, thereby avoiding the objectionable overlap so often found on roads that are constructed one-half at a time.

Considering that the road was kept open to such a large volume of traffic, the construction was carried on rapidly and at low cost.

By careful use of the tools described, the surface was true to within one-eighth of an inch on a ten-foot straight-edge. Even though one-half the road was laid at a time, the crown was perfect on completion and it is impossible to detect the center joint.

Magnetic Road Sweepers

Kind and cost of machine used by five western states, and cost and satisfactoriness of service

With a view to possibly purchasing a magnetic road sweeping machine or nail picker, the State Highway Department of North Dakota investigated what has been done by other western state highway departments, asking certain of them for four items of information: type of units used, original and operating cost, and the results obtained. Such information was obtained from the state departments of Oregon, Nevada, South Dakota, Arizona and New Mexico. The information so received is summarized below.

Type of Machine.—Oregon uses an 84-inch built-up magnet; current furnished by a 110 volt, 30 ampere D.C. compound generator, with field rheostat, the prime mover being a model D Ford motor. Mounted on a 1-ton Chevrolet truck.

Nevada uses three magnets, No. 4, type R generator, 22 inches in diameter, 5-kw, 115 volt, 43 amperes, 1200 r.p.m., manufactured by the Imperial Electric Co.; prime mover, Dodge motor mounted on a Liberty truck.

South Dakota uses a magnet, 96-inch generator, Delco power unit. Mounted on a White truck.

Arizona uses three 22-inch road sweeping magnets. Generator 3-kw 230 volts, D.C. Prime mover, gasoline motor mounted on a 3-ton Liberty truck. Rheostat with individual switch control, to each magnet used.

New Mexico uses a complete unit manufactured by the Spring and Forging Co. of Roswell, New Mexico, in which there are two 48-inch by 15-inch magnets. Power furnished by a 4-kw D.C. generator, 90 volts, 35 amperes, driven by a 9½ h.p. four-cylinder gasoline engine. Mounted on a 1-ton Chevrolet truck.

Cost of Machine.—The complete unit is in rather an experimental stage, although its component parts are all standard equipment. All of the states except New Mexico have designed and built their own units, using various arrangements and quite frequently making use of surplus war materials or a second hand equipment. Consequently very little original cost data were available. Neither Oregon or Nevada could give the cost of the unit.

South Dakota gave cost of the magnet and installing Delco power unit as $552; Arizona gave the cost of three magnets at $2,612; the truck and motor generator being obtained from the United States Government.

Operation Cost.—Oregon did not give cost of operating. Nevada gave the cost as $40 per day, operated at a speed of three to four miles per hour. South Dakota gave the operating cost as 32c per truck-mile; and as three trips are required to cover the road, this amounts to 96c per mile of highway covered. Arizona gave the operating cost as $25 per day. New Mexico gave the operating cost at 47c a mile; by making three trips over a road, 21 miles of highway can be covered in one day with a machine.

Operation.—Oregon and Nevada both report the operation as satisfactory; Arizona, as very successful; New Mexico, as very successful and says that, while several units are in use, it is planned to increase the number of units so that all the roads in the state can be covered twice a year. South Dakota says, "Denailing roads does not entirely remove danger of blow-outs and there is probably some trouble caused by leaving up-ended nails; but on the whole, punctures and blow-outs are materially decreasing throughout the season."

From these reports, the North Dakota Highway Department has drawn the following conclusions:

"1. Operating costs would amount to approximately $1.25 per mile of highway cleaned (three trips required to completely cover 24 ft. road).

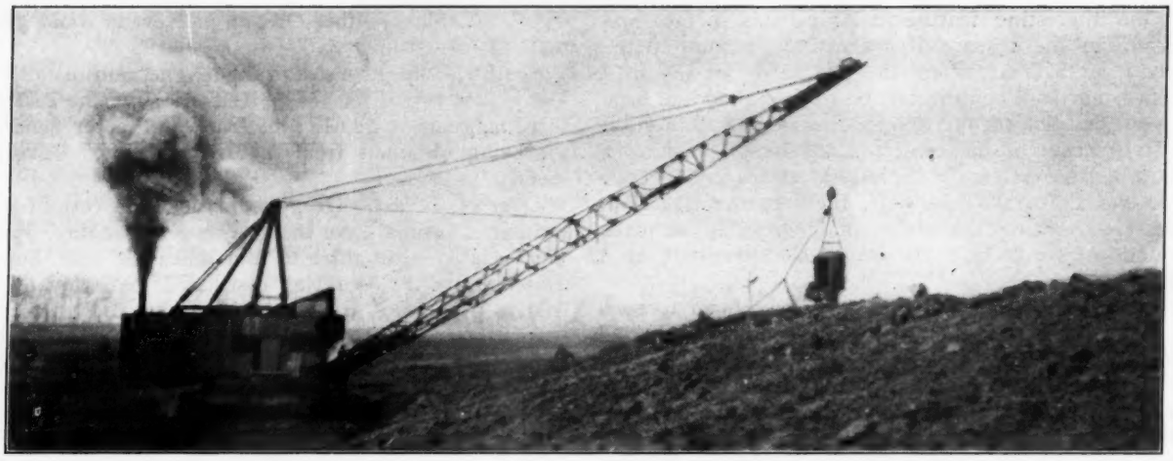
"2. One unit should be able to completely cover twenty miles of road per day (3 trips—60 truck miles) or approximately 3,000 miles during a season. If the highways should be gone over twice each season, which appears to be the general opinion, one unit would take care of 1,500 miles of highway.

"3. All states using the magnetic nail picker that we have had reports from, are apparently well satisfied with the results obtained.

"4. As to cost of machinery: The complete unit is in rather an experimental stage, although its component parts are all standard equipment. All of the States excepting New Mexico have designed and built up their own units using various arangements and quite frequently making use of surplus war materials or second hand equipment. Consequently, very little original cost data is available. Only one commercial company manufactures a machine of this type, namely, the Spring and Forging Company of Roswell, New Mexico. Price of their machine, complete including 6-cylinder Chevrolet truck and all equipment is listed as $3,850. f.o.b., Roswell, New Mexico. Price complete without truck, $3,089.00 f.o.b., Roswell New Mexico, which plus the freight and truck for mounting would cost approximately $3,928.00 at Bismarck, North Dakota."

Oakland Plans for Zoning

Oakland, Calif., in its 1929-30 city budget, allots $13,000 to enable the field engineer to carry out the instructions of the city council that he prepare data for a comprehensive zoning plan for the city of Oakland; in addition to $2,500 to pay the current operating expense of the City Planning Commission.



FIFTEEN-YEAR OLD STEAM DRAGLINE WORKING ON LEVEE

Flood Control Work in the Memphis District

Work being done and equipment used in this district, where ten million dollars will be spent this fiscal year

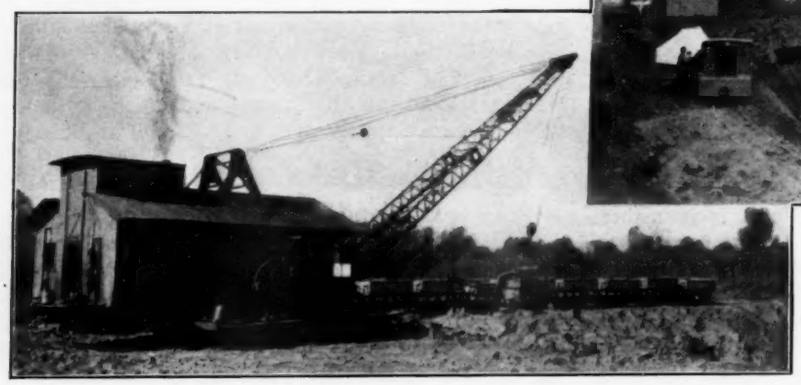
The Memphis Engineer District of the Mississippi River Commission extends from Cape Girardeau, Mo., to the mouth of the White River. This district is divided into three field areas. The first extends from Cape Girardeau to the Missouri-Arkansas line, and includes all the work around Cairo and the much-discussed Birds Point-New Madrid Floodway. The second field area extends southward to the Tennessee-Mississippi line and its prolongation; and the third, from this point southward to the White River. In the Memphis District is located a large part of the work of controlling the Mississippi which is now under way—probably half of the total expenditures this year will be in this district. And probably half of this will be in the First Field Area, where it is estimated that the expenditures for the fiscal year will amount to about $10,000,000.

This work includes additional protection for Cairo, and the construction of the floodway, as well as raising and improving various other levees in line with the general plan of strengthening and raising. This work may be divided roughly into four sections: That around Cairo; the floodway section; the Reelfoot levee district, and the St. Francis levee district.

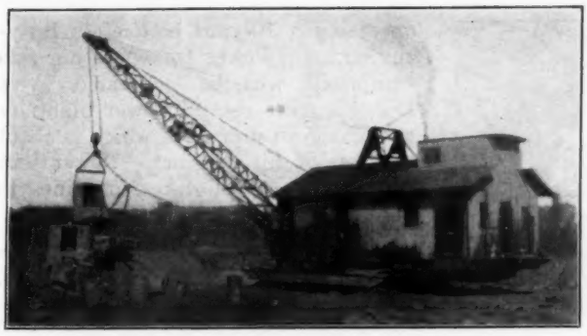
WORK AROUND CAIRO

Some of the work near Cairo is carried over from 1928. The Ward-Hayes Contract described in the January, 1929, issue of *Public Works* is still under way though nearly completed. This was delayed by slips and subsidence and by high waters which three times broke into the contractors' borrow pit and flooded it. The methods and equipment are, in general, the same as those employed last year. In addition to this, the Ward-Hayes Co. has contracts for two additional sections of levee construction. These are: Piece 2C, an enlargement job consisting of about 120,000 cubic yards just south of the present contract; and the Mound City Ohio River Front Levee, which involves about 200,000 cubic yards of work. These jobs are being carried on in connection with the hold-over work from last year.

Contracts 2A and 2B afford additional protection



ABOVE: 1½-YARD DRAGLINE FILLING 5-YD. CARS HAULED BY 12-TON GAS LOCOMOTIVE. AT LEFT: MONIGHAN 3-YD. DRAGLINE LOADING CARS AT BORROW PIT



CONTRACT 2-B BORROW PIT
Monaghan 3-yard dragline filling train of nine 5-yard cars.

to Cairo. 2A is a riverside enlargement job involving 183,000 cubic yards. Piece 2B is landside enlargement and some new construction, and requires 194,000 cubic yards. Each of these involves some hauling in of materials from borrow pits.

Contract 2A.—This contract was awarded to J. J. McCaughey & States Construction Co. at 27.9 cents per cubic yard. At either end of the contract, haul-in was necessary, since the additional material required was not available within ready reach. As shown in the plan, this work is riverside enlargement. The haul-in work was done by McCaughey, while the remainder of the work was sublet to T. W. Crow and Douglas Buchanan. At the lower end of the job there was a haul of about 1000 feet, while on the upper end the haul averaged about ½ mile, a borrow pit along the river front being used.

On the haul-in, tractors and crawler wagons, reinforced by trucks, were used. The contractor operated two 5-yard Linn tractors, 4 Western 7-yard crawler wagons, and an Indiana motor truck. The crawler wagons were teamed up with caterpillar "60" tractors. The wagons and trucks were loaded at the borrow-pit by a Northwest 1¼-yard gas shovel.

On that portion of the work where draglines could be used to advantage, Crow and Buchanan operated a 3½-yard Bucyrus steam dragline, which dug out of a borrow pit. On a part of the work a double cut was necessary, the dragline on the first trip reaching far out and throwing the main body of the riverside slope, and on the second trip taking from the nearer portion of the borrow pit and topping out the levee.

This dragline is 15 years old, and has been used by the present contractor for 13 years, but despite its age, it handled around 2500 yards a day, working on two shifts for about 22 or 23 hours per day.

Contract 2B.—This contract included both landside and riverside enlargements, and a short section of raising the levee top. A portion of the work required haul-in, and on this, the haul averaged 4500 feet. A narrow-gauge track and 5-yard cars handled by gasoline locomotives are being used. At the borrow pit is a 3-yard Monaghan dragline, which loads the cars. Two trains of 8 or 9 cars each are operated, which usually do not afford enough capacity to keep the Monaghan busy all the time. Western 5-yard side-dump cars are hauled handily by two Vulcan 12-ton gasoline locomotives. There is also a Linn 5-yard tractor, which is used on shorter hauls.

At the far end of the job, the cars dump into a pit where a Bucyrus 1½-yard dragline rehandles the dirt, and throws it out to place.

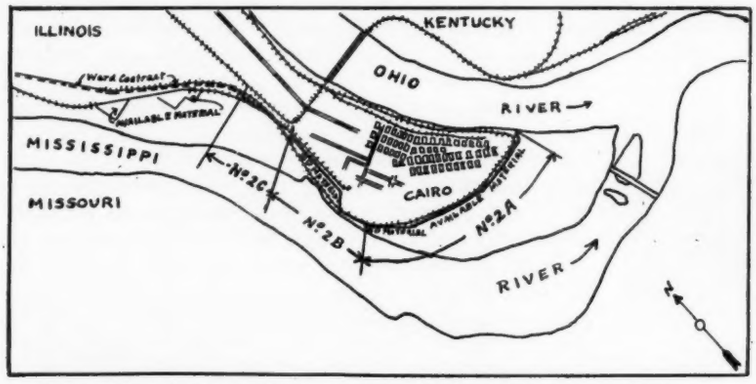
At the borrow pit, the mobility of the Monaghan dragline proves of much advantage. In general, the light railway equipment shows up well on this job, and handles a good deal of dirt with relatively small personnel.

The contractors on this section are J. H. Boyce & Sons and R. L. Igo, and the contract price on the 194,000 cubic yards of earth is 56 cents a yard. The contract is to be completed by February 11, 1930.

Contract 2C.—On this section of the work, which includes some straddle enlargement under the Mobile & Ohio tracks (which are being raised and reballasted by the railroad) and some riverside enlargement, all material has to be hauled. The price for the 120,000 cubic yards to be handled is 70 cents. The Ward-Hayes Company is doing the work, and the material is being taken from the borrow pit at Cache described in the January, 1929, issue of *Public Works*. The haul-in is 6 to 7 miles, and the material is being taken out of the pit with a 50-B Bucyrus steam shovel and loaded into 12-yard, standard gauge Western dump cars, which are hauled over the M. & O. tracks. These are dumped and spread by means of a spreader, and rehandled by an Osgood 1¼-yard dragline, which builds the levee up to the desired section, and then tops it out. There are 3 locomotives, and 30 of the dump cars operating in two trains. A Link-Belt dragline is used to dress up and finish the levee section.

Contract 3.—Ward-Hayes also is working on Contract 3, on the Ohio River Front, which involves 206,000 cubic yards awarded at 48 cents, and a small

WARD-HAYES CONTRACT. MARION STEAM EXCAVATOR LOADING CARS FROM BORROW PIT



PLAN OF CAIRO FRONT LEVEE, CONTRACTS 2 A, B AND C

amount of rock, for which 80 cents per yard is paid Part of this is land-side and part riverside enlargement, and all is haul-in. On this section the contractor has one Marion 2-yard steam shovel, one Osgood 1-yard shovel, three narrow-gauge locomotives, 39 Western 5-yard dump cars and a narrow-gauge spreader.

SIKESTON-NEW MADRID RIDGE LEVEE

The levee along the Sikeston-New Madrid ridge is being enlarged and extended to keep backwater from passing over this ridge to the south. This contract, involving 930,000 cubic yards, was awarded to W. M. Roth Construction Co. at 20 cents a yard, with the completion date set at February 13, 1931.

On this work, Mr. Roth is using a 4-yard Monaghan dragline. With this machine he has moved the following yardages per working day over 10-day periods from July 1 to October 20:

10-day period ending		10-day period ending	
July 1	3,950	August 30	4,388
July 11	3,271	September 10	4,871
July 21	4,026	September 20	3,176
July 31	3,790	September 30	3,712
August 10	3,206	October 10	4,290
August 20	4,278	October 20	4,322

Working days on this job have run around 23 hours, using two shifts of men.

BIRDS POINT—NEW MADRID FLOODWAY

Four contracts already have been let on this work, with a total yardage of 8,368,000, and one contract of about 3,000,000 yards is still to be let. Work was scheduled to begin on these jobs November 1, and most of the machinery is now (November 10) in place or nearly ready. A most interesting array of machinery will be used on these contracts, construction work on which will be described in a later issue of *Public Works*.

Contract 4A, involving 1,990,000 cubic yards, has been awarded to J. J. McCaughey at 20 cents a yard. Mr. McCaughey will use a 125-foot boom Marion steam dragline handling an 8-yard Page bucket; and on long reaches will use a 25-foot extension on the boom, with a 6 or 7-yard bucket. This will be one of the largest draglines on the river and its use will be watched with interest.

Contract 4B, for 2,056,000 cubic yards, has been awarded to Clark Bros. Construction Co. at 15¾ cents a yard. This contractor wil use a Bucyrus electrically driven tower machine, with a 125-foot head tower, operating a 10-yard bottomless Bucyrus bucket. Power for operating this equipment will be generated at a Diesel engine central power plant located at Anniston, Mo., which is about midway of his contract. Power will be carried over high-tension lines to the tower machine.

Contracts 4A and 4B will be constructed from riverside borrow pits, but 4C, 4D and 4E will be built from the excavation of a drainage canal which will intercept the drainage of the district to the north and west, which will be cut off by the floodway levee.

Contract 4C has been awarded to the J. C. Johnston Construction Co. It aggregates 2,153,000 cubic yards, and the contract price is 25 cents per yard. The contractor plans to use a cableway and towers on a track, with one tower in front of the levee and one beyond the canal section. The cableway buckets will be loaded with a dragline. On contract 4C, it is about 500 to 520 feet from the outer toe of the levee to the farther edge of the canal.

Contract 4D, involving 2,169,000 cubic yards of earthwood, has been awarded to James G. Yeats Contracting Co. at 28½ cents a yard. This contractor is planning to use a modified tower machine, with two 20-yard crawler wagons being pulled back and forth by cables, using a stiffleg Harnischfeger dragline. The wagons will be loaded by dragline. On this contract, the distance from the outer toe of the levee to the farther edge of the canal ranges up to about 580 feet, and in sections the canal is 180 feet wide, with a depth of 15 feet, side slopes of 3 on 1, and a bottom width of 90 feet.

Final location on contract 4E has not yet been made. This section will involve about 3,000,000 yards of work and will comprise the final southerly section of the floodway.

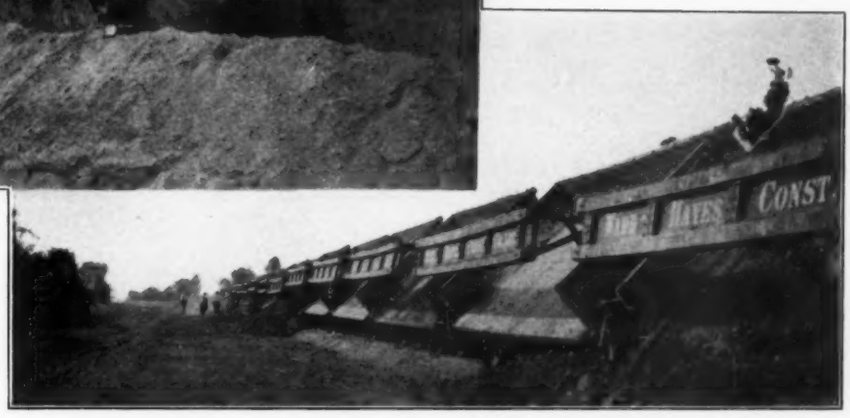
OTHER WORK IN THE FIRST FIELD AREA

There are three contracts now going on in the Reelfoot Levee District, covering a variety of work. These are of especial interest to contractors for a number of reasons, and will be described in a forthcoming issue of *Public Works*.

In the lower St. Francis Levee District of Missouri,

CARS (ON STANDARD-GAUGE TRACK) DUMPING ON LEVEE AND OSGOOD DRAGLINE SHAPING IT UP

AT THE LEFT: WARD-HAYES JOB. A 50-B BUCYRUS LOADING FROM THE BORROW PIT INTO WESTERN 12-YARD CARS



AT THE RIGHT: WARD-HAYES JOB. DUMPING A TRAIN OF CARS ON THE LEVEE

U. S. Levee Machine C-6 is working on contract No. 9, involving 1,200,000 cubic yards, which was bid in at 18.33 cents a yard. This is a Bucyrus tower machine operated by the U. S. Engineer Department by hired labor; a No. 9½ Bucyrus dragline acts as auxiliary. This outfit has handled an average of around 5300 yards a day for the past two months, going as high as 7,317 yards on one occasion.

PERSONNEL

The activities of the Memphis Engineer District, which has its headquarters in the McCall Building, Memphis, are under the direction of Lt. Col. F. B. Wilby. Major L. B. Chambers is in general charge of construction activities. The work in the First Field Area is directed by Associated Engineer T. T. Knappen. Assistant Engineer G. L. Perry is principal assistant area engineer. Inspector Clyde M. Hogue is in charge of inspection work in the Cairo area; Assistant Engineer W. A. Steele has general supervision over the upper St. Francis levee district; and Inspector H. A. Ferrell has charge of the Lower St. Francis section.

New York Department of Sanitation

The voters of New York City in November approved a law previously adopted by the Board of Estimate and Apportionment providing for the creation of a department of sanitation. This provides for a sanitary commission composed of three members to be appointed by the mayor, with overlapping terms of six years; one to be a physician and one a sanitary engineer. This commission will have complete jurisdiction throughout the city of street cleaning, snow removal, the collection and disposal of refuse, the designing and construction of intercepting sewers and sewage treatment works, and the enforcement of sanitary regulations. For a period of ten years it will be empowered to select sites for sanitation plants, subject to over-rule by twelve votes of the Board of Estimate and Apportionment. It will take over the organization of the present Department of Street Cleaning and have control over the appointment and removal of its employees.

The work of the commission will be administered under three divisions: Administration, Street Cleaning and Waste Disposal, and Intercepting Sewers and Sewage Disposal. The law became effective December 1.

Pollution of the Passaic River

That the use of the Passaic Valley sewer, which intercepts most of the domestic sewage formerly reaching the Passaic river up to and including Paterson, would not result in a flow of clear water of pleasing appearance has been stated several times in PUBLIC WORKS; for it will be necessary to prevent also the discharge of large amounts of waste waters that reach the river from industries. This has been found to be very difficult. Eleven injunction suits have been filed against industries and towns that continue to pollute the river and 24 more suits are under advisement. In addition to dye wastes, oil from garages and boats, garbage dumped along the shores and other polluting matters are reaching the river. In August members of the Rivers and Harbors Committee of Congress and a Federal Grand Jury inspected the river with a view to some action which would remedy the condition.

During August, owing partly to the reduced volume of flow in the river because of the dry season, the condition of the water was worse than at any time since the intercepting sewer went into service. Boating, which had been resumed, was discontinued because of the offensive appearance and odors. There was a total depletion of dissolved oxygen at five points in Passaic and Newark, although just above the mills in Paterson the river contained dissolved oxygen to 46 per cent of saturation.

Charges for Sewerage Service*

By Frank A. Marston†

This subject has to do with methods of raising funds to pay the annual cost of the operation and maintenance of sewerage systems including pumping stations and treatment plants; and to pay that portion, if any, of the annual fixed charges, such as interest and bond maturities, resulting from the construction of sewerage works not otherwise provided for by tax levy or assessments.

It has been the usual practice to obtain all of these funds from the general tax levy apportioned *ad valorem* over the property of the entire municipality. The disadvantages of this method have led to the adoption, by a few cities and towns, of annual charges or rentals for sewerage service similar to charges made for water by water departments. These annual charges or rentals for the use of the sewers are in addition to assessments levied at the time the sewers are built. The benefits already shown by the adoption of such methods have aroused widespread interest and discussion.

Such methods can be adopted more readily when the system is started or when a treatment plant is built.

ENABLING ACTS

Laws have been passed in at least six states (Ohio, Pennsylvania, Wisconsin, New York, Michigan and North Carolina) enabling cities, towns, districts or other municipal corporations to make charges annually for sewerage service. The subject is under active consideration in some other states, and in Massachusetts and Texas the plan has been used by several cities and towns without a special act. The General Laws of Massachusetts provide that any municipality, except Boston, may establish annual charges for the use of common sewers. Some private corporations in New Jersey are operating sewerage systems and are collecting rentals at rates approved by the State Board of Public Utility Commissioners. Ohio was the pioneer state in passing a sewer rental law (1923).

CHARGES BASED ON THE USE OF WATER

The annual charges for sewerage service may be computed on the basis of the water used, by one of the following methods:

1. A graduated scale of rates depending on the amount of water used as shown by readings of the water meter, and by an estimate where no meter is installed or where the user has a private water supply. A minimum charge is usually provided.

2. A two-part rental, consisting of (a) A "ready-to-serve" fee, graded according to the size of water meter installed or other basis; and (b) A graduated scale of rates or estimate as in No. 1, or a uniform rate as in No. 4.

3. A percentage charge added to or based on the bill for water.

4. A uniform rate for all water consumed.

Some illustrations of the several methods will be given.

An example of method No. 1 of charging for sewer service is that in use at Dayton, Ohio, where a new sewage treatment plant is about ready for operation. The sewer rental law went into effect February 1, 1928.

Based on the quantity of water used per quarter year as shown by meter readings, the rates for property within the city limits are as follows:

Quantity Per Quarter Year	Per 1,000 cu.ft.
First 3000 cu.ft. or less	$1.00
More than 3000 cu.ft. and less than 10,000 cu.ft.	.30
More than 10,000 cu.ft. and less than 20,000 cut.ft	.25
More than 20,000 cu.ft. and less than 100,000 cu.ft.	.20
More than 100,000 cu.ft. and less than 500,000 cu. ft.	.15
More than 500,000 cu.ft.	.10

There is a minimum charge of $1.00 per quarter year or part thereof.

For property outside of the city limits the rates are about 25 per cent higher.

For prompt payment of bills, a discount of 5 per cent is allowed; while for failure to pay promptly, an additional charge of 5 per cent is added. Bills are payable quarterly with the bill for water. The rental is made a lien on the property. In case of failure to pay the charge, it can be put on the tax duplicate and collected as other taxes are collected. It is estimated that these rates will produce sufficient revenue to pay the entire cost of operation, maintenance and fixed charges of the sewerage works.

Method No. 2 is followed in the Washington Suburban Sanitary District of Maryland where the operating and maintenance costs of both water supply and sewerage works are met by a meter service or "ready-to-serve" charge and a water consumption charge.

A similar schedule, but for sewerage service only, has been proposed for Grand Rapids, Mich., in which there is a "ready-to-serve" charge based on the size of meter and a water consumption charge, as follows: (reference 11).

Ready-to-serve charges vary from $6.00 per year for ⅝-inch and ¾-inch meters to $381.00 per year for 6-inch meters. Consumption charges vary from 5 cents per 100 cu. ft. for the first 2,200 cu. ft. used annually, to 2 cents per 100 cu. ft. for all water used in excess of 200,000 cu. ft. annually.

Wellesley, Mass., makes an annual minimum charge of $6.00 together with $1.00 additional fee for each water meter, in excess of one, used on each premise; and an additional charge at the rate of 18.5 cents for each 100 cu. ft. of water, in excess of 2,200 cu. ft. used per year.

The No. 3 method is in use at Framingham, Mass. A sewerage service charge of 35 per cent of the water bill is rendered quarterly at the same time the water bills are sent out. As in the case of other methods, special adjustments are made where private water

* Paper before the American Society for Municipal Improvements, Philadelphia, Oct. 16, 1929.

†Partner of Metcalf & Eddy, Engineers, Boston, Mass.

supplies exist or where the volume of water discharged to the sewers is materially different from the water meter readings.

In Brockton, Mass., a sewer rental plan, like No. 4, has been in use since 1894. At present the charge is 15 cents per 100 cu. ft. of water as shown by the water meter readings, but it has been as high as 22½ cents. If all of the water passing the meter is not discharged to the sewer, the property owner must install a meter to measure such water or else pay a charge based on the whole amount.

For the year ending November 30, 1928, the Brockton sewer department obtained funds for maintenance, operation and fixed charges from the following sources:

Sewer rentals	61.0%
General tax	37.5%
Other sources	1.5%
	100.0%

CHARGES BASED ON FLAT RATES

Where water meters are not in general use, the charges must be based on other means, such as:

5. A flat rate per house connection, with suitable corresponding rates for apartment houses, industries and other types of property.
6. A scale of rates depending on the number and kind of fixtures connected to the sewer system.
7. A combination of Nos. 5 and 6.

A combination of flat rates and fixture rates, method No. 7, is in force at Delaware, Ohio. Some of the representative items in the schedule of charges per year are:

Dwellings and Apartments:
One-family (one connection)—$4.00.
Hotels:
For each room with bath, $1.75
Rooming Houses and Fraternities:
$4.00 plus $1.00 for each person renting a room therein.
Stores, Restaurants, Office and Mercantile Establishments:
Private toilets, each $4.00
Public toilets, each $8.00
Factories and Shops:
For each employee from $1.00 to $0.60 according to number employed.
Churches:
For each toilet, $2.00
Colleges: For each registered student $0.75.

Such a schedule, if worked out in an equitable manner, can be used successfully and is applicable to municipalities where the water services are not metered.

CHARGES BASED ON CHARACTER OF SEWAGE

Where the sewage is treated, the cost of operation and maintenance of the sewage treatment plant is influenced by the character of the sewage, including industrial wastes, ground water and other leakage. Certain industrial wastes may add a considerable burden of expense because of their character; whereas relatively clean rinse waters, although of similar volume, would not involve a corresponding cost. To meet these conditions it is possible to set up the following:

8. A schedule of charges based not only on the volume of domestic sewage or industrial wastes but also on the degree of pollution as measured by relative amounts of suspended matter, the biochemical oxygen demand, or some other factor.

Such a system was proposed by Tanner for Dallas, Texas (reference 13). Where conditions warrant, such a method can be worked out in considerable detail. With other methods of financing, it may be necessary to select certain industries and to charge them special rates based on the quantity and quality of industrial wastes discharged to the sewers.

SOME OBJECTIONS THAT HAVE BEEN RAISED TO SEWERAGE SERVICE CHARGES

The billing and collection of rental or service charges requires clerical assistance and involves expense and other complications of administration.

Some property owners may prefer to pay one bill for taxes rather than to have a separate bill for sewerage service.

The billing of charges for service as well as for the cost of the connection may cause some property owners to delay making a sewer connection until forced to do so by ordinance.

Service charges cannot be billed until sewer connections are made and any unforeseen delay in construction may delay the receipt of funds, thereby throwing an unexpected burden on other sources of revenue. This would apply particularly to the first year or two after starting to build the system.

A residential community does not require the various classifications of service found in an industrial city and, therefore, the complications of a rental system may not appear justified.

It may be claimed that the municipality as a whole should bear a substantial part of the burden. In Massachusetts, the municipality as a unit must pay at least one-fourth of the total cost of construction.

ADVANTAGES OF SERVICE CHARGE PLAN

Any equitable plan by which funds can be obtained continuously for sewerage operation and maintenance without depending on appropriations from the tax levy will have the following distinct advantages:

Funds can be provided continuously and adequately to ensure efficient operation and the best service.

The source of revenue will not be in direct competition with other more popular budget items in the tax levy.

The funds will not be subject to economy cuts at the whims of disinterested officials.

Each property owner will pay only his fair share of the cost in accordance with his use of the system.

Taxpayers having no sewerage facilities will not be required to pay for maintaining the service rendered others.

The sewerage system, and especially the sewage treatment plant, if any, can be maintained in efficient condition and thereby avoid waste of public property.

The availability of funds will permit engaging trained operators and adequate labor, and will make possible the operation of the sewerage system as a self-supporting public utility comparable with the water supply system.

The funds can be limited in use to the purposes intended, which, as the New York law puts it, are the "payment of the cost of the management, maintenance, operation and repair of the sewerage system, including treatment and disposal works."

While there may be ample justification in theory for obtaining funds from the tax levy for these purposes, the facts remain that many sewerage systems have suffered seriously and sewage treatment plants have been ruined for lack of funds, whereas these troubles might have been avoided if an annual service charge plan had been in operation.

SOME THOUGHTS REGARDING SERVICE CHARGES

Definite rules for preparing a schedule of service charges cannot be given, because conditions vary so in individual problems. There are some general principles, however, that it may be well to consider.

The sewerage system is an important public utility and as such should be provided adequately with funds to permit it to render the service for which it was designed. Those who benefit should pay a price commensurate with the service received, based on the fair average cost of rendering that class of service. The prices charged for the various classes of service should be in proper proportion one to the other and sufficient in aggregate amount to provide the required sum. The rates should be selected so as to provide, as nearly as can be estimated, for the average costs over a period of at least five years and perhaps ten years in the future.

Where the water services are metered, the meter readings may serve as a convenient basis for determining equitable sewerage service charges. Under some conditions a more equitable distribution can be made if the charge is divided into two parts, a "ready-to-serve" charge and the "extent of use" charge.

The "ready-to-serve" charge is a charge on account of the general benefit received and should be collected from every owner whose property has a connection to the sewerage system, whether sewage is discharged or not. This is similar in principle to the meter service charge levied by many water departments. It also serves as a minimum rate and tends to lower the rates charged for actual use.

While it may be argued that a property owner having paid for the house connection and having been assessed on a "frontage and area" or other basis for a part of the cost of the common sewer, has already purchased the privilege of being connected to the system, there remains a considerable portion of the plant (especially if treatment is provided) to the maintenance of which the property owner should contribute whether sewage is discharged or not. This can be accomplished through the "ready-to-serve" or minimum charge.

Annual interest and bond maturities or sinking fund payments and certain clerical and administrative expenses must be met regardless of the volume of sewage collected. Ground water leakage adds to the volume to be treated without being affected by the discharge from fixtures. There is justification, therefore, in levying a charge that is not dependent on the extent of use of the system.

It may not be practical to make the "ready-to-serve" charge pay for the full amount of the interest and bond maturities, not otherwise provided for, because thereby the average householder might be forced to pay an undue share; but it may be reasonable to collect in this manner a portion of that sum, leaving the balance together with operating expenses to be covered by the "extent-of-use" charge. Where the owner has been assessed for the house connection and part of the common sewer there is not the basis for determining the "ready-to-serve" charge that is available in the case of water meter service charges.

The "ready-to-serve" charge may be graded according to size of water meter, number of families served per connection, area of land, or other means that will distribute the burden fairly and be easy of application. From $3.00 to $6.00 per year per connection for the average residence is charged in some of the schedules now in force.

The "extent-of-use" charge will depend largely on the quantity of water used as shown by water meter readings, unless conditions are such as to warrant an additional classification based on the character of the sewage discharged. Adjustments must be made and special rates charged for cases to which the usual rule is not applicable.

The foregoing discussion has been limited to general considerations and many important details have been omitted. The conditions in any particular problem will affect the determination of equitable service charges. That there is merit in this method of providing for the cost of operating and maintaining sewerage works is evidenced by the number of municipalities that have either adopted it or have it under serious consideration. It is particularly applicable and can be more easily put into effect where a sewage treatment plant is being constructed. To change over an old system may involve troublesome complications but is not necessarily prohibitive. The importance of providing adequately for the efficient and continuous operation and maintenance of sewerage works cannot be over-emphasized. A reasonable method of financing through annual service charges makes such operating conditions possible and is worthy of careful study.

REFERENCES RELATING TO CHARGES FOR SEWERAGE SERVICE

The following references will be of value in studying the details of the several ways in which service charges have been made. The letter following the reference indicates that the article contains examples of (L) laws or ordinances, and (R) schedule of rates.

1. A Plan for Meeting Water-Supply and Sewerage Costs; R. B. Morse & Abel Wolman, Eng. News Rec., June 2, 1921, p. 944 (R).
2. The Washington Suburban Sanitary District; R. B. Morse; Proc. Am. Soc. Mun. Imp. 1926, p. 181 (R).
3. Rates of Charge for Sewerage Service; S. A. Greeley, Am. Soc. Mun. Imp. 1926, p. 278 (R).
4. Financing, Rental and Amortization of Private Sewerage System at Troy, Pa.; H. W. Taylor, Am. Soc. Mun. Imp., 1926, p. 290.
5. Financing the Baltimore Sewerage System; M. J. Ruark and C. E. Keefer, Eng. News Rec., May 5, 1927, p. 724.
6. Sewer Service at Manila Charged for on Metered Water Consumption Basis; Eng. News Rec., Sept. 8, 1927, p. 404 (R).
7. First Annual Report of Ohio Conference on Sewage Treatment, October 26, 1927 (L) (Dayton ordinance and others in Ohio).
8. Financing Sewage Treatment by Ohio Sewer Rental Law; Water Works April, 1928, p. 173.
9. Financing Sewer Maintenance; L. B. Reynolds, Jour. Calif. Sewage Works Assoc., 1928 (R) (L).
10. 14th Annual Meeting, N. J. Sewage Works Assoc., March 22-23, 1929 (L).
11. Campaign to Make Sewers a Utility Continued at Grand Rapids; Eng. News Rec., March 7, 1929, p. 391 (R).
12. Making Sewage Disposal Pay Its Way; G. J. Wagner, Am. City, May, 1929, p. 157 (R).
13. Distribution of Costs of Sewerage Systems; W. S. Tanner. Abstracted in Proc. A. S. C. E., August, 1929, p. 1423; also Eng. News Rec., May 2, 1929, p. 715 (R).
14. Financing the Operation and Maintenance of Sewage Treatment Plants; Ernest Boyce, Munic. News, July, 1929, p. 305 (L).
15. Sewage Treatment in Wisconsin; L. F. Warrick, Sewage Works Journal, July, 1929, p. 481 (L).
16. Sewer Charges Authorized in New York State; Eng. News Rec., July 4, 1929, p. 10 (L).

THE EDITOR'S PAGE

Combined or Separate Sewers

In his review of the case of Lake Michigan diversion at Chicago, on page 455 of this issue, Mr. Howson says that most of the sewers in the Chicago Sanitary District are on the combined system, but had a recommendation of the 1887 report been adopted "nearly 80% of the present sewer mileage would have been on the separate system . . . and the problem of building intercepting sewers and of caring for storm-water overflows would have been much simplified;" and, as he shows elsewhere, the city would have been saved millions.

This condition results from the necessity that Chicago treat its sewage. New York and Philadelphia also are treating some and preparing to treat all of their sewage. It was once thought that large cities would forever be free from this necessity, but the fallacy of this is being learned. Modern civilization is demanding some sewage treatment of practically all cities, large and small.

Granting the necessity of treating sewage, and there remains little valid argument for combined sewers. Combined sewers are allowed only by special permission, we believe, by all state health boards that are given control of that matter. With combined sewers in use, the streams can not be safeguarded, difficulties are caused at the treatment plants, prevention of odors and deposits in the sewers is difficult, and even the promised economy in construction costs ultimately disappears in most cases. Few, if any, new ones should be built, and most existing ones should gradually be replaced with separate sewers.

Make Them Glad to Pay Taxes

"I think the dollars and cents can be lost sight of when we give service to a municipality. . . . Plan right and go ahead; I believe the taxpayer will meet you more than half way."*

We believe that these words, spoken of the New Orleans taxpayer, apply to most taxpayers throughout the country. Once they learn that the tax proceeds are being used with honesty and reasonable economy to give them service, they will not protest against an increase necessary to give more service or for other reasonable purpose.

Objection to payment of taxes is chiefly due to the idea, often too well justified in the past, that only a small part of them was used for the benefit of the taxpayer, the larger part going — well, elsewhere. This is still true to a certain extent in a few cities, but we believe it to be almost universally true at the present time that the taxpayer gets more service for his tax dollar than for almost any other money he spends. The convenience of a sewerage system costs him less than the inconvenience of a cesspool. His garbage and ashes are removed and disposed of without nuisance (to him or his neighbors, at least) for much less than he would have to pay by private arrangement to have them dumped on a near-by lot. He rides comfortably over streets paved and cleaned better, and at less cost, than if each property owner contracted separately for paving and cleaning in front of his own property.

We believe it is part of the duty of city officials to bring the taxpayer to realize the benefits he receives and the fact that his taxes are used in providing them; that the comforts of a modern city are not the gifts of a beneficent providence, his by right like the air he breathes, but can be obtained only by and in proportion to his tax payments. He pays as much in a year for and on his car as his total tax payments for the construction, cleaning and lighting of the streets he uses it on, the removal of his garbage, ashes and sewage, police and fire protection, free libraries and scores of other conveniences. Only a fool would say that his car was worth more to him than all these.

It would seem practicable for city officials to "sell" to the taxpayers any additional service which would be of real general advantage—to make them glad to pay additional tax therefor. For such tax would be really small. A cent a day per family will pay the total annual cost of a highest-class sewage treatment plant. Two or three cents a week will pay for removing their garbage. An even smaller sum will pay for white-way lighting the business district; the cost of a cheap cigar a week will pay for a park for his children to play in.

Does it seem probable that a people which has a car, a radio set, a telephone and electric lights in the great majority of its homes would not jump at such bargains in improved services and conveniences if the matter were properly put up to them? Not if they believed that the money furnished for providing the services would be honestly and efficiently used.

To convince them of this, it should suffice to prove to them that last year's taxes were so used. And that should not be difficult for a public works official if he makes an earnest and intelligent effort—and if it is so.

For Better Flood Control

The proposal to hold at Memphis an exhibition of levee building machinery we believe to be an excellent one. Levee construction is not a standardized proposition to-day. New sections, involving greater amounts of earthwork per station, are rendering inadequate the methods and equipment which have served in the past. No one knows to-day whether big or little draglines, tractors and trailers, industrial railways, tower machines or dredges, or combinations of them, are most economical and suitable for any given present-day construction.

To solve these problems by individual experience is slow and costly. Cooperation and mutual helpfulness will result in better work at lower cost, and in less hazard and loss to contractors and residents. We believe there should be such an exhibition and we also believe that it should be supplemented by a meeting in which the contractors and the levee engineers could come together in a spirit of cooperation to solve the many problems of the industry. Levee construction is a big job and one worthy of the best of engineering and construction brains and equipment.

* From paper by Carl Schneider in the November issue of PUBLIC WORKS, page 424.

Equipment for a Road Job With Heavy Excavation

Heavy equipment of late design was employed in the construction of 8.28 miles of highway between Andover and Greenwood, located in the western part of New York State. This road crosses the watershed between the St. Lawrence valley, in which Andover is located, and the Susquehanna River drainage system at Greenwood. At Andover, the road has an elevation of 1662 feet, and rises to 2306 feet in passing over the divide, falling to 156 feet at Greenwood. The alignment is very winding, and a great deal of new location was necessary in order to keep the grades within the 7% maximum.

The contract was awarded to H. E. Bunce of Olean, N. Y., for $435,173.70. The work involved 113,700 cubic yards of unclassified excavation and 74,000 cubic yards of fill. The unit price on excavation was 35 cents per yard. The 8.28 miles of pavement amounted to 58,159 square yards of concrete surfacing. Shoulders are of earth, 5 feet 6 inches wide. The work is to be completed by January 1, 1930. Except for finishing and shoulders, the work was practically all completed before November 1.

For handling earth excavation, the contractor used four Bucyrus-Erie steam shovels with ¾-yard buckets, and a Northwest 1-yard shovel. These loaded into motor trucks, and into crawler wagons drawn by tractors, which handled the earth to the fills. The crawler wagons were 6-yard La-Plant-Choate, which were handled by two Caterpillar 60 tractors. The motor trucks included six 3½-ton Hugs, two 2½ ton Hugs, three 2½ ton Macks, one 5-ton Mack and four International Harvester 2-ton trucks. There was also used for knocking down the fills, working on the subgrade, and general grading work, an Adams leaning-wheel grader which was drawn by one of the Caterpillars. There was comparatively little rock excavation and this was handled by the shovels without trouble.

There were five bridges on the contract, varying from 12 to 40 feet in span. Three of these were of the reinforced concrete slab type and the others were I-beam. All were of 30 feet clear width. The excavation for these was handled by the power shovels, and the paving over them was done just as on the rest of the road. Culverts up to 24 inches were of cast iron, larger ones were of the concrete box type. The smaller culverts were trenched out by hand, but power shovels were used for all the larger ones. The pipe was generally placd by hand.

The pavement was of the standard New York state type, 8 inches thick at the edges and 7 inches at the center, 18 feet wide, and laid in two lanes, each 9 feet wide. Truscon steel mesh reinforcement was used, with end dowels, and an extra layer of reinforcement was placed at the end of each block. Standard portland cement was used, with a 1:2:3½ mix. Meadows "Sealtite" expansion joints were placed at intervals of 78.5 feet.

The form placing gang consisted of 4 to 6 men, as a rule, who worked from 500 to 1,000 feet in advance of the mixer. Blaw-Knox and Abernethy forms were used on this work. The fine grading gang was equipped with a Buffalo-Springfield 5-ton gas roller, with scarifier, and two steam rollers. There was also a subgrader for excavating for forms, and for excavating between the forms. This was pulled by a tractor or one of the rollers. A Koehring subgrade planer was also used, running on the forms just back of the mixer. There was no hauling on the finished subgrade. There was some old macadam on the Andover end of the job, which was scarified and broken up prior to laying the concrete.

A 27-E Koehring mixer was used for mixing the pavement concrete, and a 7-S Koehring was also on the job, being used principally on culvert and bridge construction. The entire mixing and finishing gang comprised 14 or 15 men, as a rule, as follows: 2 men unloading batch boxes and dumping them into the skip; 1 mixer operator; 4 men spreading concrete; 1 man operating the finisher; 2 men on surface finishing, edging, and brooming; 2 men covering and sprinkling; and 2 or 3 men sprinkling the hay. The average day's work of this gang ranged from 1200 to 1500 feet of one lane; with a maximum of 1750 feet. Concreting began June 15 and ended September 15, which represents an average daily output of nearly 1200 feet of finished pavement per day, including delays from all causes. As a rule, the daily production was maintained at an unusually regular pace.

A Lakewood finisher was used; the entire finishing gang, as noted above, comprised 7 or 8 men. Curing was accomplished by covering with burlap as soon as the concrete was set up enough, and next morning the burlap was removed and the concrete covered with hay, which was kept wet for 10 days. The pavement was opened to traffic in 15 days.

Materials were shipped to both Andover and Greenwood, as the work progressed. Unloading was accomplished with a Universal crane with clamshell bucket, which loaded into a Blaw-Knox bin. A Lakewood measuring device batched the material as it was discharged into the batch boxes. Each batch box, with a capacity of about 60 cubic feet, was loaded with one complete charge for the mixer. The boxes were carried by motor trucks, each truck handling two 7-bag batch boxes at a load. At the mixer, these batch boxes were picked up by a crane operated by a power takeoff from the mixer, and dumped into the skip, the empty batch box being replaced on the truck. This method is preferred by the contractor to that of having the truck bodies partitioned so as to carry the batches.

The water for the job was obtained from a creek along the road, through one line of 2-inch pipe. A Barnes triplex pump was used, and the pump moved as often as necessary to keep the pipe line within a maximum length of two miles.

Because of the rough and hilly nature of the country through which the road passes, it was not considered practicable to maintain traffic during construction, and the road was closed and traffic detoured around the section.

Local labor was used, no camp being maintained. A force of about 125 men was on the job during the most of the construction period. Harold Kinney was in charge for the state, working under the supervision of the district engineer, O. J. Dempster, at the district offices in Hornell. H. E. Bunce, the contractor, was in charge of the construction work.

The Public Works Department in Cities

A study of this subject has been made by Clarence E. Ridley and the results set forth in a recently-issued pamphlet of fifty pages. Mr. Ridley, who has been in succession assistant city engineer, city engineer and city manager, and is now executive secretary of the International City Manager's Ass'n. and associate professor of public administration at the University of Chicago, brings practical experience to his study of the departments of twenty-five American cities. His report should interest all municipal officials in any way connected with the execution of public works functions. Paragraphs are quoted below giving the more important of his conclusions and general observations on the subject; the supporting data and arguments, given in the report, being omitted because of limitations of space.*

The cities whose departments were studied ranged in size from two million (Philadelphia) to thirty thousand (New London), and were about equally apportioned among the three principal forms of city government, viz., mayor-council, commission, and council-manager.

There is neither unanimity of opinion nor general understanding as to what is comprehended by the term *public works*. Such municipal activities as the construction and maintenance of streets, bridges and sewers, the furnishing of services for public convenience, and the general administration of public property are commonly accepted as coming within the scope of a public works department. On the other hand, the operation of utility enterprises, park development, supervision of regulatory inspections, etc., give rise to a difference in opinion.

It is here contended that all municipal activities requiring engineering technique for their satisfactory administration should be classed as public works functions. This, in many cases, may involve problems under the jurisdiction of several other city departments. The selection and development of suitable sites for city institutions and other municipal buildings, and the custodial care and operation of public property are illustrations in point. The public works department of a city, therefore, might well be considered not only as one responsible for the administration of various important city activities but also as one of general service for other city departments.

The important part that public works play in municipal government arises from the fact that they are indispensable to modern urban life. Fully one-half of the total cost of municipal government today is expended either for universally accepted public works activities or for permanent improvements requiring technical engineering supervision.

An analysis of the total cost of municipal government for the year 1926 in the 250 cities of the United States with populations in excess of 30,000 shows that 11.6 per cent of the total cost was expended for the operation and maintenance of general public works functions; 5.1 per cent more for the operation of public service enterprises, such as water works, light plants, markets, etc.; 29.3 per cent for outlays involving the acquisition and construction of more or less permanent properties and public improvements; and 9.0 per cent for interest on that share of the city indebtedness attributable to purposes requiring the technical supervision of an engineering staff. These figures represent 55 per cent of the total expenditures for the period. The corresponding percentages for the years 1924 and 1925 were 55 and 53.2, respectively.

While the other service departments of a city are mainly ones of personnel, a public works department, on the other hand, spends approximately one-half of its appropriation for material consumed in its work.

* "The Public Works Department in American Cities," issued by the "Municipal Administration Service," New York City.

CLASSIFICATION OF PUBLIC WORKS ACTIVITIES

To claim that certain municipal functions belong exclusively within the realm of public works activities is to ignore the fact that circumstances in individual cases defy any such dogmatic classification. On the basis of the present data, however, it is possible to separate the functions into three groups which might, for the purpose of this discussion, be termed customary, occasional and incidental.

1. *Customary functions.* Under customary functions are classed those functions which are executed by the public works department in the majority of the cities. They include: street design, improvement and maintenance; street cleaning; sidewalks; street lighting; excavation permits; street name signs; house numbering; bridge design, construction, and maintenance; sewer design, construction and maintenance; sewage disposal; refuse collection and disposal; maintenance of all city-owned motor equipment; and inspection of the construction of public improvements.

2. *Occasional functions.* Under the heading occasional functions are classed those functions which are not executed by the public works department in the majority of cities but which are handled by that department more often than by any other single department. They include the operation and supervision of municipal utilities;* care of public buildings and grounds, equipment other than motor equipment, and drinking fountains and comfort stations; and the inspection of street lighting.

3. *Incidental functions.* Incidental functions include those functions which are handled by the public works department in some of the cities, but are executed more often by some other department. They include care of street trees, cemeteries and tourist camps; the planning, improvement and maintenance of parks and playgrounds; the maintenance and operation of bath houses; inspection of purchases; and all the service and regulatory inspections except street lighting.

* The water works system is operated by the public works department in eleven cities, by the department of public utilities in five, and by a separate water department in eight. In one city, Reading, it comes under the department of parks and public property. The other utilities, as a rule, are privately owned and operated, but whatever supervision is exercised over them by the city is usually executed by the public works department.

There is also a marked difference of opinion with regard to the wisdom of placing utilities, such as water works, within the public works department. Yet Chicago, Philadelphia, Boston and Baltimore include the furnishing of water among the activities of this department.

NEW CONSTRUCTION

It is worth while to observe that very little new construction is carried out by day labor. Of the five largest cities, Philadelphia, Cleveland and Milwaukee do practically no new construction by day labor; Baltimore does about 25 per cent, and Boston but 10 per cent. Flint does 75 per cent of its new construction by day labor and is the only one of these cities above 100,000 population apparently committed to this policy. Two of the smaller cities, however, Lynchburg and New London, do practically all new construction work by day labor, the figures being 90 and 95 per cent, respectively.

ADMINISTRATION

In council-manager governed cities the head invariably receives his appointment from the city manager. In cities under the commission plan he is, of course, elected. It should be borne in mind, however, that the elected commissioner appoints an engineer to administer the technical engineering activities of the department. With this exception, which is more apparent than real, the administrative heads of the public works departments are all technically trained engineers. In three of the cities, however, Philadelphia, Cincinnati and Yonkers, technical training is not an essential qualification.

SUGGESTED PRINCIPLES OF ORGANIZATION

To suggest what might be termed *principles of organization* is a hazardous undertaking, to say the least. It is proposed here, however, to present merely what might be called, more appropriately, those rules of action on which there is some unanimity of opinion. Briefly stated, they are:

1. Grouping within basic organization units all activities similar in the type of work to be done.
2. Grouping a sufficient number of activities to warrant the full time of a competent person.
3. A clear definition of the powers and duties of each division.
4. Effective coordination between divisions.
5. Elimination of duplication.
6. Centralized and coordinated control.
7. Definite fixation of responsibilities.
8. Powers commensurate with responsibilities.
9. Recognition of the distinction between line and staff activities.
10. Expert staff available for the administrative head.

General application of these rules to a group of activities without using a liberal amount of discretion is not recommended. Any grouping of activities should be preceded by a comprehensive study of the character and extent of the particular work to be done. Due consideration should be given also to the suitability of the personnel that will be called upon to operate the organization. The final result, therefore, will be a compromise between a scientific division and the existing circumstances, which will give proper weight to the many limiting factors which characterize any given situation.

The number of divisions or bureaus into which a department should be divided for effective administration is another question that cannot be answered dogmatically. The number of activities that one individual can be technically competent to administer is to be considered, as well as the fact that there should be few enough divisions to enable the department head to know his division heads well, and to be in close enough touch with actual administration to facilitate intelligent direction and control over major problems. The department head should also be able to make sure that details are being effectively handled by others. In the last analysis, however, the factors which will very largely govern the number of divisions are the magnitude and diversity of activities to be handled.

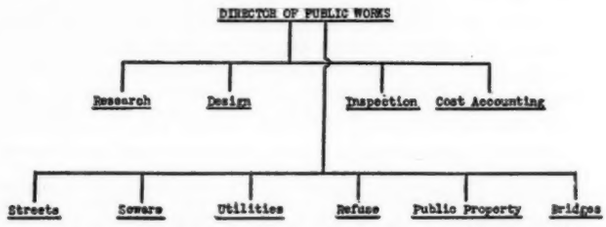


FIGURE 1. PUBLIC WORKS ORGANIZATION, LINE AND STAFF TYPE

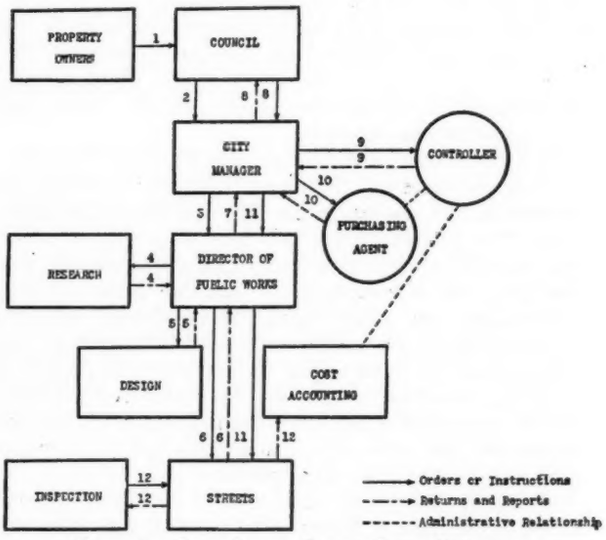


FIGURE 2 CHART SHOWING STEPS IN PAVING PROCEDURE

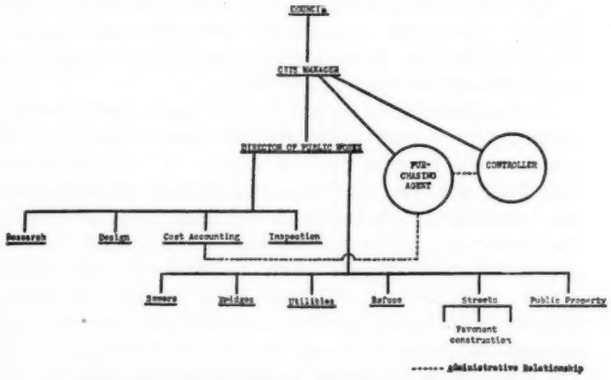


FIGURE 3 ORGANIZATION CHART FOR USE WITH FIGURE 2

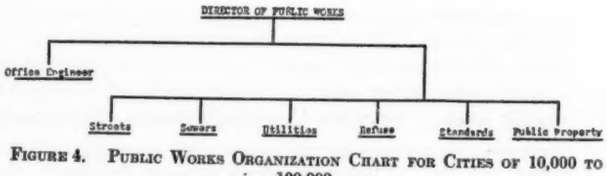


FIGURE 4. PUBLIC WORKS ORGANIZATION CHART FOR CITIES OF 10,000 TO 100,000

GENERAL TYPES OF ORGANIZATION

The usual plans of organization either follow closely or are adaptable to certain types, which are more or less well defined. The three most common ones are: (1) line, (2) staff and (3) line and staff. . . . The line and staff type of organization possesses most of the advantages of the two other types and eliminates many of their defects. It retains the idea of specialization, but eliminates the chief defect of the pure staff type by centralizing in the executive head the issuance of all orders and the exercise of control, instead of placing them partly with the specialists. The strong feature of the line type, definitely fixing duties and responsibilities from the top to the bottom, is therefore preserved.

Perhaps an illustration of how an administrative matter would actually be handled under the line and staff type of organization would help in understanding its operation. The diagrams show how a petition for a pavement would be routed from its inception to the actual construction of the pavement. Fig. 2 gives the various steps in the procedure, and Fig. 3 shows the governmental organization which carries out these steps. The separate steps vary in different cities. Those listed herewith are offered merely to illustrate how the matter is likely to be handled under a council-manager form of government:

1. Petition to the council by interested property owners.
2. Petition referred by the council to the city manager.
3. Petition referred by the manager to the director of public works.
4. Petition passed to the research bureau to see that the improvement harmonizes with the city plan and to ascertain whether any insurmountable obstacles, such as proposed sewer or water main installations, would prevent immediate construction. If the cost of the pavement is to be met by special assessments, this bureau would also investigate the affected property owners' financial ability to meet the obligation, and perhaps suggest a cost that would be in line with what the district could reasonably stand.
5. The above information, if favorable, after being conveyed back to the director, would result in an order to the bureau of design to make the necessary surveys and prepare the plans, specifications and estimates for the improvement.
6. The matter upon being reported back to the director, would doubtless be referred to the head of the bureau of streets for his approval, in order to prevent this agency, which would probably be responsible for its construction and certainly for its maintenance, from raising any questions after the work had been authorized by the council and the contract awarded.
7. The director, after attaching a copy of the necessary ordinance, would refer it to the manager.
8. The manager, in turn, would report it back to the council and obtain authority to advertise for bids and proceed with the work in accordance with the attached plans, specifications, etc.
9. With this authorization obtained, the manager would next send notice of the action to the controller who would encumber the proper appropriation to the amount of the estimated cost.
10. The manager would next refer the data to the purchasing agent who furnishes only general supervision over the work being carried on by contract, a representative of the inspection bureau would be detailed to the job to see that the work was executed in accordance with the plans and specifications which were prepared by another staff bureau already described.

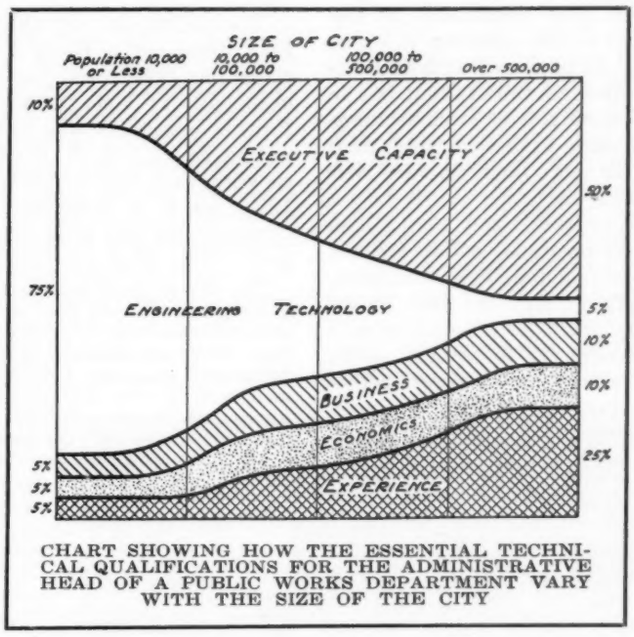


CHART SHOWING HOW THE ESSENTIAL TECHNICAL QUALIFICATIONS FOR THE ADMINISTRATIVE HEAD OF A PUBLIC WORKS DEPARTMENT VARY WITH THE SIZE OF THE CITY

There are many possible modifications of the above procedure even in cities with the same type of government. This is offered merely as suggesting the way a certain matter might be handled so as to make full use of the specialist and still have the control and responsibility definitely fixed at each step in the operation.

The author gives charts depicting the organization structure of public works departments for cities of various sizes, applying the principles of organization discussed above. That for cities of 10,000 to 100,000 population is shown herewith. In cities of 10,000 to 100,000, the distinct separation of staff and line activities becomes more discernible (See Fig. 4, page 484.) An office engineer will take over the staff activities, and the size of this unit will depend entirely upon the work to be done. Streets and sewers will, very likely, be placed in separate bureaus, and engineers with at least the rank of juniors put in charge of the different line bureaus. It might be advisable in rapidly expanding cities near the upper population figure, to place a works engineer over these line bureaus, in order that the director may devote more of his time to general policy and to more intensive study of important projects.

THE ADMINISTRATIVE HEAD OF THE PUBLIC WORKS DEPARTMENT

Board vs. Single-Headed Control—In the development of an entirely new public enterprise, there is some justification for the creation of a board to work out in a deliberative manner the many factors that are bound to arise, but, as soon as this process of development is finished, the administration of the project should be turned over to a single executive. The board system has never been justifiable for a great active department of a city government, like that of public works, where promptness of action and fixed and definite responsibility are imperative for effective operation.

Engineer or Lay Head?—Should the single head of the public works department be a trained engineer or a layman? There is little to be gained from a repetition of the arguments which are advanced by the enthusiasts for both viewpoints. In substance, the objection to having an engineer or expert as the administrative head is based upon the supposition that he is likely to overemphasize the importance of technical questions at the expense of others of a more general nature, while the opposition against the layman is raised on the ground that he is likely to place undue importance upon political expediency, and understress sound and proved technique.

This phase of the problem probably can be ap-

proached best by considering the broad general functions which devolve upon the administrative head of a public works department. Speaking generally, these may be grouped into two classes, viz., (1) directing and controlling operations, and (2) maintaining contact with other department heads, with his immediate superior and with the public. It follows that the former would very likely be handled more competently by an engineer, while the latter would, in all probability, be discharged more expeditiously by a layman, who is not so susceptible to rigid routine and red tape as is the expert. If these premises are accepted, then the problem of whether an engineer or layman should be selected would depend to a large extent upon which of the two functions were paramount in any given situation. An answer to this question is by no means a simple one. It is quite obvious that both functions are esential for effective administration, but in varying degrees under different sets of circumstances. If a generalization can be made in this instance, their relative importance would be more likely to vary with the size of the city than with any other single factor. For example, smaller cities are less likely than larger ones to have problems involving broad public policies. In cities, say, of between 100,000 and 500,000 in population, especially the upper figure, the time of the administrative head is very likely to be ocupied with matters requiring a knowledge of economics, public law and finance, together with a broad experience in big undertakings, rather than with strictly engineering technology. Under such circumstances, the appointment of a lay head with suitable qualifications might be fully justified.

Essential Qualifications Vary With Size of City—It is true that certain qualifications of an administrative head of a public works department are essential regardless of the size of the city. This is especially true with reference to what may be termed personal qualifications, which include honesty and integrity, tact, personality, social mindedness and basic common sense.

On the other hand, essential technical qualifications are more likely to vary with the size of the city. They include engineering technology, executive capacity, a knowledge of modern business systems, the ability to interpret economic conditions, and actual experience which will, in turn, develop judgment, persistency and courage.

The accompanying chart is intended to show graphically the relative importance of these technical qualifications and how they are likely to vary with the size of the city. The dividing lines, of course, should be considered as merely indicating trends and not be regarded as being in any wise rigid or inflexible. For example, in cities of 10,000 population or less, executive duties will be rather simple, and will, therefore, probably require no more than 10 per cent of the time of the administrative head of the department, while it is quite likely that 75 per cent of his time will be devoted to matters involving engineering technology. In larger cities, however, these conditions are practically reversed; executive duties increase rapidly, until in the largest cities at least 50 per cent of the administrator's time will in all probability be devoted to general supervision and control, while the time that he will devote to matters of engineering technology is likely to have decreased to as little as 5 per cent. In the meantime, the other three essntials—a knowledge of modern business systems, economic conditions, and actual experience which are each accorded 5 per cent in the small city—will have increased to such an extent that for the largest cities, the first two are 10 per cent and the last, 25 per cent. Between these two extremes all the qualifications will, of course, assume varying degrees of importance.

Who First Constructed Brick Pavement on a Lime-Rock Base?

The article in our October issue entitled "Lime-Rock Base for a Brick Road," in which the author stated his belief that the first road of this kind had been built by Georgia, has brought letters from two Florida engineers who believe that he was mistaken in that belief. W. E. Sheddan, city engineer of Jacksonville, says such a pavement was laid in his city in 1924; and C. E. Burleson, county engineer of Pinellas County, cites such construction in that county the same year. Mr. Sheddan writes:

The city of Jacksonville early in 1924 constructed a 40-ft. street practically one mile in length using a 6" compacted limerock base with a sand-cement cushion and 3" vertical-fibre brick with bituminous filler, and since that time has constructed probably 125,000 surface yards of brick pavement with varying thicknesses of limerock base, depending upon traffic conditions; some were 4" compacted limerock base; some were 6" compacted limerock base and others were 8" compacted limerock base. On approximately 70,000 yards of this pavement the old brick were taken up and relaid on a limerock base, sand cushion and bituminous filler.

In 1924 and 1925 Duval County rebuilt some 20 or 30 miles of 16-ft. county highways, relaying the old brick on a 6" compacted limerock base with sand cushion and bituminous filler. These particular stretches of road are now a part of the state highway system, approximately 5 miles being on State Road No. 3, leading out of Jacksonville in the direction of Orange Park, about three miles being a part of State Road No. 4 leading out of Jacksonville in the direction of Waycross, and the other on state highway leading out of Jacksonville in the direction of St. Augustine.

That portion of the relay brick on the limerock base on the St. Augustine road, constructed by Duval County, has since been re-surfaced with an asphalt wearing surface by the State Highway Department.

This is in no way intended as a criticism of Mr. Coleman's article, as it was excellent and his facts were all good, except he probably was not familiar with the work that we had done in Jacksonville and Duval County.

Mr. Burleson's letter is as follows:

"I have just read a very interesting article in your issue of October 1929, captioned "Lime Rock Base for a Brick Road," by J. F. Coleman, maintenance engineer, State Highway Board of Georgia, which article is highly interesting to me from the fact that Mr. Coleman is of the opinion that he can justly lay claim to the honor of this being the only road of its kind in existence, viz., brick surface on a lime rock base. Mr. Coleman has written a very splendid article on this type of construction.

"However, this particular type of construction is nothing new to this county, as we have constructed some 33 miles of vitrified brick surface on a lime rock base, the first of which was laid in the year 1924; our method of construction being practically the same as that laid on State Road No. 38 in South Georgia with the exception, however, that our filler was squeegeed over the entire surface and was covered with approximately 10 lbs. of granite squeegee cover material in order to produce a non-skid surface.

"I am writing this letter only in order that the fact may be known that this is a standard type of pavement in this part of Florida and has been for some five or six years past.

St. Louis Paving Company's New Asphalt Plant

The Bridges Asphalt Paving Co., of St. Louis, Mo., put into operation last September a plant for making an asphalt paving mixture which uses a process different from the standard of years past, although the mixture produced is the same and is furnished to the city in carrying out its specifications for paving.

The first run of this plant was for a contract for a 2-inch asphaltic concrete surface on a 6-inch portland cement concrete base in Fair Grounds Place, a short, narrow street. The proportions of the mixture were: Bitumen, 7.6%; dust, 7.0%; chats, 25.4%; stone, 60.0%. The aggregates were dried and stored as formerly, and raised to three overhead bins for sand, dust and coarse aggregate by means of chain bucket elevators. The dust elevator is enclosed. Directly under the bins, over which enclosed rotary screens are mounted, is a hopper into which all three bins empty. This hopper is swung on the beam of a scale which measures each type of aggregate separately. The aggregate is used at the required temperature of about 350°F. The hopper has the shape of an inverted pyramid with a hole about one foot square at the bottom, directly above the hole in the mixing drum when the latter is in the receiving position. The hopper holds sufficient aggregate to make a five-ton batch of asphaltic mixture.

The man who weighs out the aggregate also weighs out the asphalt cement. In place of the open-top asphalt bucket of the pug-mill type of plant, this asphalt container is a small tank suspended on scale beams. Enough asphalt at the correct temperature is weighed out inside this tank to make the five-ton batch. The asphalt cement enters this small suspended tank under pressure and is forced into the mixing drum under pressure also, steam at 120 lb. being used for this purpose.

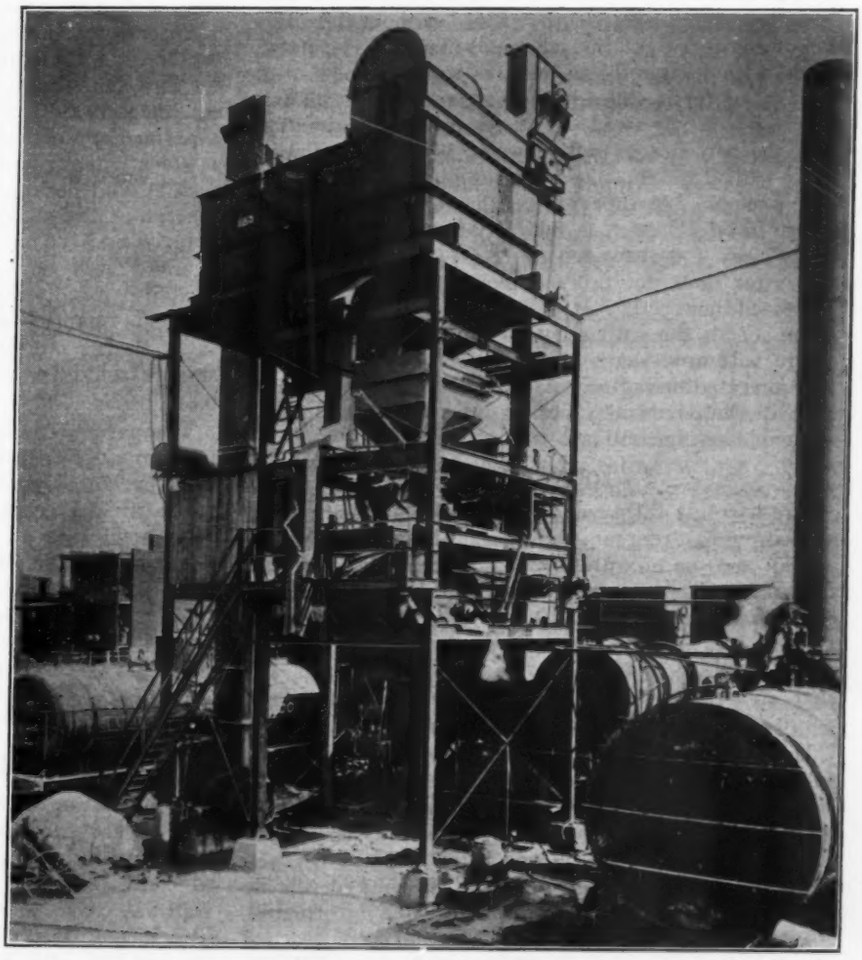
The aggregate is dropped from the hopper into the mixing drum below, and the drum is then sealed. A mixing period of two minutes follows, during which the hot aggregates are the only things in the drum. After this dry mixing period, the asphalt is introduced under pressure through a duct in the center of the axle of the drum. A fifty-pound air pressure is then put on the drum and the whole mixture is rotated for an additional four minutes. A minute is consumed filling and emptying the drum. This sequence permits from eight to nine five-ton batches per hour.

The following crew is required at the plant: 3 men shoveling sand and chats, 1 man handling dust from cars to elevator, 1 man filling hopper and handling drum, 1 man on scales, 1 man emptying hopper and firing driers, 1 fireman, and 1 foreman.

Among the advantages claimed for this method are uniformity, no variation of mixture more than 0.5%; economy of machine parts, of materials, and of truck time; accurate weighing of all aggregates; and impregnation and water-proofing of aggregates. The process is patented, the mixing drum being placed in service with the contractor on a rental basis. The president of the company, Edward Bridges, states that economies effected by using this process pay for the rental of the drum.

The city maintains a laboratory at the plant for supervision and control of the mixtures. For this contract the mixture was trucked about five miles in an open-top dump body truck and then dumped directly onto the base and shoveled to place with forks. The following gang organization was used on the street: 1 foreman, 4 rakers, 5 shovelers, 2 tampers, 1 back man, 1 helper in back, 1 truck dumper, and 3 roller men on one 15-ton, 3-wheeler, Springfield roller and two 10-ton Buffalo-Springfield rollers.

The superintendent for the contractor was C. E. Crider and his street foreman was C. F. Stuart and plant foreman, Charles Geis; Mart Thompson was chief asphalt chemist for the city, and C. W. Bornemann was inspector on the street.



ASPHALT PLANT OF THE BRIDGES ASPHALT PAVING CO.

Effect of Iron Compounds on Sludge Digestion

The numerous studies made by the New Jersey Agricultural Experiment Station on sewage treatment during the past few years have included the effect of different iron salts and compounds on digestion and sedimentation of sewage and on sludge conditioning. The results to date have been made public by Dr. Willem Rudolfs, chief of the Department of Sewage Disposal.

SEDIMENTATION

The laboratory has compared the actions of certain precipitants and coagulants (under a grant from the National Aluminate Corporation), in a study, not so much of chemical precipitation, which requires large quantities of chemicals, as of a flocking-out process, which possibly can be accomplished with small amounts of chemicals. If these will hasten sedimentation, it will be possible to use smaller sedimentation tanks than is now practicable, even when aided by mechanical devices.

Ferric chloride ($FeCl_3$) was added to raw screened sewage at the Plainfield plant in quantities ranging from zero to 15 p.p.m., and the rates of settling determined after 1, 2, 3, 5, 7, 10, 12, 15, 20 and 30 minutes by analyses made of the suspended solids removed; a check being run for each addition of iron chloride. These indicated that while, without the addition of any ferric chloride, the percentage of suspended solids settled after thirty minutes was about 24, with 2 p.p.m. of ferric chloride the percentage was 38, and with 5 p.p.m. it was 53. With ten minutes sedimentation, the percentages settled were: without treatment, 14.5; with 2 p.p.m., 32; with 5 p.p.m., 49; and with 10 p.p.m., 65. It appears that the ferric chloride has a certain effect which is felt very shortly after application (say for about ten minutes) and that settling thereafter does not proceed more rapidly than with untreated material. "It seems possible that with 5 p.p.m. $FeCl_3$ the sedimentation time might at least be cut in half or perhaps require only one-third of that for untreated sewage. . . . Small quantities of iron chloride help considerably in the sedimentation of settleable sewage solids."

DIGESTION

Fresh solids collected at the Plainfield plant were seeded, and different quantities of ferrous sulfate added, and the mixtures incubated at about 70°F. A mixture was prepared consisting of ripe sludge (6.90% solids, 45.1% ash) and fresh solids (5.17% solids, 20.5% ash), giving combined contents of 6.45% solids, 35.4% ash. To this mixture was added 26 grams of ferrous sulfate per liter of fresh solids.

The percentage of volatile matter reduction in the mixture with the iron sulfate added was greater during the first part of digestion than that in the mixture to which no iron had been added, but was less at the end of 35 days. There was little increase between the 35th and 60th days, when the percentage volatile matter reduction was: untreated, 46.2%; treated, 44.7%. The peak of gas production was reached several days earlier with the treated than with the untreated material.

Comparison also was made between the Plainfield sludge, from strictly domestic sewage, and that from Trenton sewage, which receives considerable amounts of pickling liquors. "Without wishing to make the statement that the difference in behavior" of these two "is caused solely by the pickling liquors, it is of interest to show what unseeded Trenton solids do. The solids under consideration contained 4.35% solids, of which 35.0 was ash, 10.1% iron as Fe, 5.06% sulfates and 0.023% C1. When these unseeded solids and also Plainfield solids were incubated at 80°F, both experienced a reduction in c. c. of gas per gram of volatile matter from about 17 to about 2 or 3, but the Trenton solids rapidly recovered and reached a peak of 22 cc after 14 days, whereas the Plainfield solids did not reach their peak of about 21 for 165 days. The Trenton solids were about three days old when incubated and the Plainfield only about one day, but this would not materially affect the conclusions. Gas production was practically over in 60 days with the Trenton solids, but not for about 200 days with the Plainfield ones.

SLUDGE DRYING

It is well known that ferric chloride added to activated sludge causes the sludge to give up its water more easily and rapidly. The experiments reported by Dr. Rudolfs were made to learn the time required for digested sludge to dry on filter beds when different amounts of iron chloride had been added. The experiments were made in the ordinary way, using a given quantity of sludge, removing the water by suction, and noting the time required. The moisture content of the sludge cake was taken as a basis for comparison. "The amount of moisture that can be removed with more or less prolonged filtering under suction is usually not more than 25% of the total, and it is this quantity we are primarily interested in, because sludge produced from plants treating domestic sewage could be handled with such a moisture content."

Comparing results after a filtering time of fourteen minutes, with different amounts of iron chloride used per cubic yard of sludge, it was found that the moisture was reduced to about 81% with 1 pound of iron chloride; to 75% with 2 pounds; to 72% with 3 pounds; with little additional benefit in adding more than 3 pounds, and beyond 6 pounds increased the moisture, which rose to 75% with 22 pounds of iron chloride. For practical purposes, 2 to 3 pounds per cubic yard would seem to be the best amount to use.

The Cuban Central Highway

Construction of this highway is progressing at the rate of about a mile a day and more than two-thirds of it has been completed, or about $45,000,000 worth at contract price. The completed work includes the highway from Havana east to the boundary of the Province of Matanzas and west to Los Palacios, Province of Pinar del Rio, and also about 171 miles in the provinces of Camaguey and Oriente.

RECENT LEGAL DECISIONS

"DRAINING" NOT SYNONYMOUS WITH "SEWERS" AND "DRAINS"

The Ohio Court of Appeals, Lichtenwalter v. City of Akron, 25 Ohio App. 108, holds that the word "draining" in a statute, General Code, section 3812, authorizing cities to improve streets by draining or by the construction of sewers, drains, etc., is not synonymous with the words "sewers" and "drains," as therein used, and the words "draining" used in a resolution of necessity and in subsequent legislation enacted by a city council for the improvement of a street is not broad enough to clothe the city with power to assess, upon abutting property, any part of the construction of a storm water sewer or drain in such street, since the Legislature, as shown by the wording of the statute, must have recognized the fact that a street may be drained without constructing a sewer or drain.

EXPENSE OF BRIDGE NEAR COUNTY LINE

The Illinois Court of Appeals, Second District, holds, County of Whiteside v. County of Lee, 250 Ill. App. 204, that under Cahill's St. c. 121, paragraph 41, providing that the bridges and culverts on roads or county lines and on roads within 80 rods of county lines shall be built and repaired by such counties, the expense of repairing a bridge on a road which is not entirely within 80 rods of the boundary, and where no part of the bridge is within 80 rods of the county line, must be borne by the county in which the bridge is situated.

RIGHT OF COUNTY TO SUE AND BE SUED

At common law a county could neither sue nor be sued. It is only by virtue of statutory or constitutional authority that an action may be maintained either by or against it. A suit by or against a county must be in its corporate name, that is, the name prescribed in the statute or constitution by which it may sue or be sued. County of Clay v. Curtright, 251 Ill. App. 371.

COUNTERCLAIM BY ROAD CONTRACTOR FOR DELAY IN DELIVERING GRAVEL

In an action against a road contractor for the purchase price of sand and gravel, the defendant counterclaimed for loss and expense resulting from the plaintiff's failure or inability to supply promptly the necessary quantity of gravel. Defendant's witnesses testified that at least 10 or 12 days were lost at an expense per day of $28. It was not clear that the plaintiff was entirely at fault, the evidence showing his inability to secure a sufficient number of cars. A sum of $75 allowed by the trial court on the counterclaim was held fairly equitable. Remsen Sand & Gravel Co. v. Voiles Const. Co., Iowa Supreme Court, 221 N. W. 502.

MUNICIPALITY'S RIGHT TO DRAIN SURFACE WATER

The New Jersey Court of Chancery holds, Consolidated Safety Pin Co. v. Town of Montclair, 139 Atl. 909, that the right of a town to drain surface water in its natural course to a brook is not lost through the action of private owners artificially diverting the course in grading a street on their land, and the town's acceptance of the street and adoption of the grade. The town may revert the course, no rights having accrued to the proprietors below by prescription or equitable estoppel.

MONEY LOANED TO ROAD CONTRACTOR TO PAY FOR LABOR AND MATERIAL NOT WITHIN BOND

The Oregon Supreme Court holds, State ex rel Hagquist v. U. S. Fidelity & Guaranty Co., 265 Pac. 775, that the loaning of money to a contractor constructing a public highway to pay for labor and material to be used in the work is not a furnishing of labor or material within Oregon Laws § 2991 requiring a contractor's bond therefor, and the lender cannot sue on the bond in the state's name to collect the money loaned.

WHERE PRELIMINARY DECLARATION OF NECESSITY IS OR IS NOT REQUIRED

Where the charter of a city requires a preliminary declaration of necessity, the Michigan Supreme Court holds, Reliance Automobile, etc., Co., v. City of Jackson, 244 Mich. 232, 221 N. W. 290, it is jurisdictional and the proceedings are void in the absence thereof; but where the charter requires not such preliminary declaration, proceeds for a street improvement are not void because of its absence. Even though an assessment for a street improvement should be held invalid, bonds therefor having been issued and sold, the work done and accepted, and the contractor paid, the cost and expense thereof may be reassessed. And where the abutting owners, plaintiffs in a suit to set aside the assessment, knowing all these things, have stood aside until the opening of the street for traffic, they can have no relief in equity from the cost of the improvement.

PAVING COMPANY RELETTING WORK TO ITS STOCKHOLDERS HELD NOT A MONOPOLY

The Michigan Supreme Court holds, People vs. Detroit Asphalt Paving Co., 244 Mich. 119, 221 N. W. 122, that a corporation organized for the purpose of laying sheet asphalt and dealing with a city by competitive bids, reletting portions of its paving to contractors who were also its stockholders, was not a trust or monopoly within Mich. Laws 1899, No. 255 (Comp. Laws 1915, §§ 15013–15026) as amended by Laws 1925, No. 60, and supplemented by Comp. Laws 1915, §§ 15033–15039, so as to authorize annulment of its franchise, where it appeared that the corporation was not organized for the purpose of creating an unreasonable restraint of trade, but was organized as a matter of necessity, the city having closed its asphalt plant and none of the contractors being able to maintain a plant for the limited amount of work.

"PUBLIC NECESSITY" FOR PAVING—"LOWEST AND BEST" OF TWO BIDDERS

Where a city council, desiring to grade and pave certain streets under the Oklahoma paving act, Laws 1923, c. 173, p. 278, providing that it may be done whenever the public necessity may require it, regularly adopts a necessity resolution, declaring that it

is necessary to grade and pave such streets, it complies with the act, and an objection that the words "public necessity" are not used is without merit, White v. City of Pawhuska, 265 Pac. 1059. The word "necessity" in connection with condemnation proceedings does not mean an absolute but only a reasonable necessity, such as would combine the greatest benefit to the public with the least inconvenience and expense to the condemning party and property owner consistent with such benefit. Under the paving act, one may be legally the "lowest and best" bidder, even where there are only two bidders, grammar to the contrary notwithstanding.

CONTRACTOR'S RIGHT TO SUE FOR GRADING PERFORMED ON DEFAULT IN PAYMENT

The California District Court of appeal, First District, Boyd v. Ibbetson, 265 Pac. 887, holds that where the owner of a tract of land was in default in his payment for the work of grading streets, which by his admission was done according to specifications and under the direction of his own agent, the contractor had the right to consider his contract at an end and to sue for the reasonable value of the work done. In such an action for the reasonable value of services in grading and curbing streets and constructing sidewalks, where contracts providing for a price of 35 cents per cubic yard for grading were relied on by both parties, it was held that the contract price was prima facie evidence of the reasonable value of the grading. But recourse could not be had to the price in the grading contract—the only contract between the parties—to measure a voluntary service of hauling sand and gravel, a transaction separately sued upon and separate from the grading contract, and recovery could not be had therefor when its reasonable value was not shown.

COUNTY COMMISSIONERS NOT LIABLE FOR FAILURE TO PROVIDE BARRIERS, ETC., ON STATE HIGHWAY

The Oklahoma Supreme Court holds, Guthrie v. Brown, 265 Pac. 113, that in an action against members of a board of county commissioners in their individual capacity, for damages caused by failure to provide signals, lights, barriers or warning signs upon a highway where a bridge is under construction by an independent contractor, where the petition fails to allege, and the evidence fails to show, that the accident occurred on a county highway, designated as such, but did show that it occurred on a state highway, and there was no allegation or proof that the commissioners were acting in any capacity other than as usual officials, the evidence was wholly insufficient to sustain a judgment against them.

LAYING A SEWER HELD GOVERNMENTAL FUNCTION—CITY NOT LIABLE FOR GAS EXPLOSION

In an action against a gas company and a city for the destruction of plaintiff's house by an explosion of gas alleged to have occurred through the negligence of the defendants in the laying of a sewer and gas main, the Kansas Supreme Court held, Foster v. Capital Gas & Electric Co., 265 Pac. 81, that the construction and maintenance of a sewer is a governmental, as distinguished from a ministerial or proprietary function, and the Kansas court believes it "the better and more reasonable rule to hold that (except in injuries arising from defects in streets or highways) the municipality is not liable when engaged in performing governmental functions." For this reason judgment for the plaintiff was reversed as to the city, with instructions to render judgment for the city.

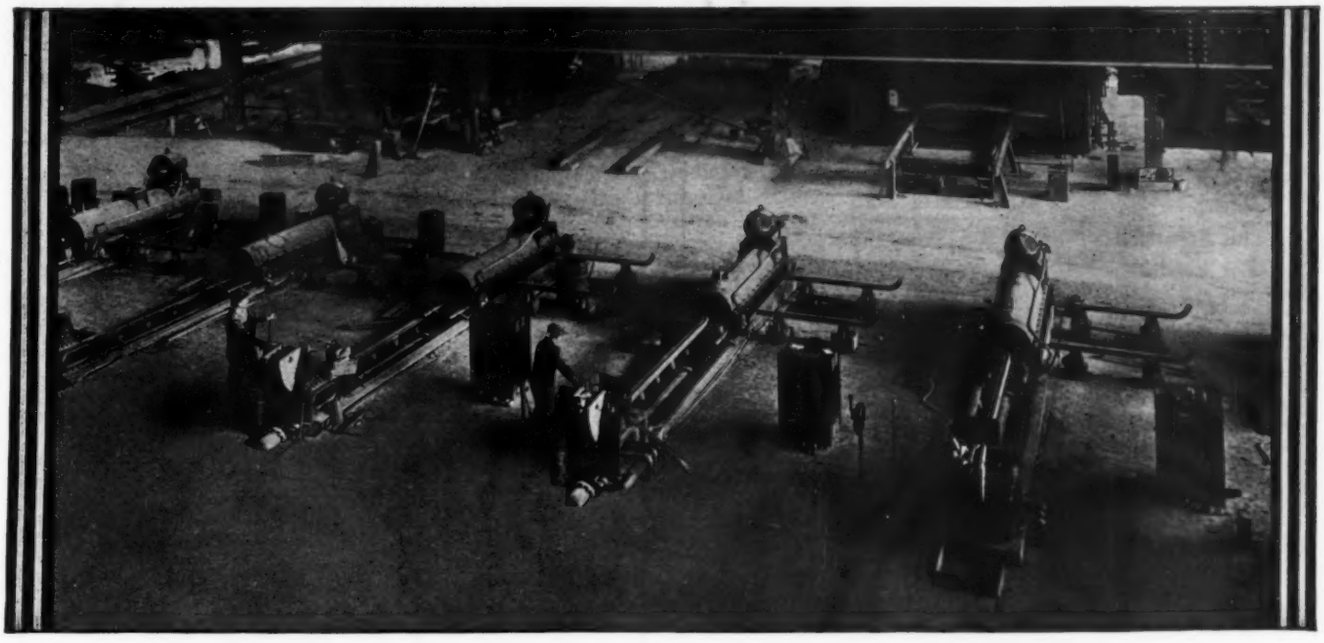
TOWN'S DUTY AS TO BARRIERS AT CURVES OF ROADS

In an action against a town for the death of a truck driver when the truck went over an embankment at a curve in the road, where the town's liability rested on its failure to maintain a barrier sufficiently strong to stop a truck suddenly turned against it, the New York Appellate Division, Carner v. Town of East Greenbush, 233 N. Y. Supp. 533, said: "Before the advent of the automobile, barriers were intended chiefly to indicate the presence of danger and to arrest the progress of a horse straying from the beaten path of the highway. Now conditions no doubt demand greater responsibility and care. It may be that the state, in constructing main highways principally for travel by automobile, should be required at places of unusual danger to locate barriers to stop and hold such a vehicle proceeding at a reasonable rate of speed. But a town is not charged with that duty in relation to its common dirt roads." Judgment for plaintiff was reversed and a new trial granted for the reason that the verdict was against the weight of evidence on the questions of negligence and contributory negligence.

OPERATION OF WATER SPRINKLER IN STREET FOR USE OF CHILDREN HELD A GOVERNMENTAL FUNCTION

The Court of Appeals of District of Columbia, Tillman v. District of Columbia, 29 F (2d) 442, holds that the District, when installing, maintaining and operating a water sprinkler for the comfort, amusement and pleasure of the children of the community, was discharging a public or governmental function, and therefore was not liable for damages to a child of nine who, while playing under and around the sprinkler, was knocked down by a passing automobile, and this even if negligence of the operator were established. It appeared that the sprinkler was voluntarily established by the District; that it was publicly maintained and operated for the comfort and pleasure of the children of the community, and served incidentally to promote the cleanliness and health of the children who made use of it; that the service was for the common good of all, and was rendered to the public without charge, and that no pecuniary profit or other special corporate advantage resulted from it, nor was any enforced contribution assessed upon individuals particularly benefited by it, by way of compensation for its use. It was held that these facts brought the case within the definition of a governmental service.

The court quoted Mr. Justice McReynolds in Harris v. District of Columbia, 256 U. S. 650, 652, as follows: "It is established doctrine that when acting in good faith municipal corporations are not liable for the manner in which they exercise discretionary powers of a public or legislative character. A different rule generally prevails as to their private or corporate powers. * * * Application of these general principles to the facts of particular cases has occasioned much difficulty. The circumstances being stated, it is not always easy to determine what power a municipal corporation is exercising."



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Engineering Societies

Dec. 4-6—NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION. Annual Meeting at Chicago, Ill.

Dec. 12-13 — HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL. Annual Meeting at Washington, D. C. Director, Roy W. Crum, B and 21st Streets, Washington, D. C.

Jan. 11-18—AMERICAN ROADBUILDERS' ASSOCIATION. Annual Convention and Road Show, Atlantic City, N. J. C. M. Upham, Director, National Press Building, Washington, D. C.

Jan. 20-23 — NATIONAL CRUSHED STONE ASSOCIATION. Annuel Convention at Cincinnati, O.

Jan. 28-30—NATIONAL SAND AND GRAVEL ASSOCIATION. Annual Meeting at Memphis, Tenn.

Asphalt Paving Conference

The Eighth Annual Asphalt Paving Conference was held at the West Baden Springs Hotel, West Baden Springs, Ind., October 28 to November 1. The attendance was unusually good, about 400 being present at the meetings. The technical sessions were well attended and were run with a pretty fair adherence to the program as scheduled. The papers presented were of unusually high caliber.

The session opened on Tuesday morning with the official opening addresses. LeRoy M. Law, president of the Asphalt Association, was the first speaker. He was followed by W. J. Emmons, president of the Association of Asphalt Paving Technologists, and by Frank O. Hodson, of the American Asphalt Paving Association. These were responded to by a representative of the Governor of Indiana and by J. J. Brown, director of the Indiana State Highway Department.

At the remainder of this session, the need of low-cost farm to market roads was stressed by Sam H. Thompson, president of the American Farm Bureau Federation, by Ernest N. Smith, executive vice-president of the American Automobile Association, and by R. W. Crum of the National Research Council. Mr. Crum emphasized the need for research in solving the problem.

At the afternoon session, two subjects were considered—first, that of cooperative research and standardization; second, state construction progress on low-cost roads. Under the first heading, H. S. Fairbank, chairman, Research Committee, U. S. Bureau of Public Roads, outlined the extent of Federal participation in the program, and described the research work now under way. Prevost Hubbard, chemical engineer of the Asphalt Association, followed with a statement of the activities of the association in such research work. J. T. Pauls, of the Bureau of Public Roads, closed this phase of the program with a statement concerning the progress made in field work by the Bureau.

Six papers were presented under the general head of "State Construction Progress," outlining progress and methods of work in as many states. B. P. McWhorter, asphalt engineer, Georgia Highway Board, described in some detail the surface treatment methods used on the sand-clay roads of that section, and the generally very satisfactory results accomplished. "Retread Construction," by A. H. Hinkle, maintenance superintendent of Indiana, was of great interest, because of the excellent results accomplished by this method of resurfacing, the use of lantern slides to illustrate the methods of construction, and Mr. Hinkle's personality and vigorous delivery. There was considerable discussion of this paper. J. S. Watkins, state highway engineer of Kentucky, led the discussion and was followed by B. E. Gray of West Virginia. The Tuesday afternoon session closed with a most practical and interesting account of "Oiled Earth Roads in Illinois," by D. O. Thomas, superintendent of highways of St. Clair County, Illinois.

A county fair and carnival provided entertainment in the evening.

State construction progress was continued at the Wednesday morning session. The first paper presented was "Asphaltic Treatment of Earth Road Surfaces in Fresno County, Calif.," by Chris P. Jensen, who was not present. His paper was read by Mr. Rosengarten. "Better Treatment of Gravel Roads in Minnesota," by F. C. Lang, testing engineer of the department, vied in interest and discussion with the paper presented on Tuesday by Mr. Hinkle. "Surface-Treated Gravel and Macadam in Oregon," by R. H. Baldoch, maintenance engineer of the Oregon Highway Department, closed this phase of the subject.

The general subject of discussion for the remainder of the Wednesday morning session was subgrades and bases. It was opened by C. A. Hogentogler of the Bureau of Public Roads, who discussed "Treatment of Subgrades With Asphaltic Oils" in his usual thorough manner. W. C. Buetow, state highway engineer of Wisconsin, discussed "Causes and Control of Frost Action in Shoulders and Subgrades." The final contribution of the subject was "Block Bases for City Pavements" by J. H. Dingle, city engineer of Charleston, S. C.

The Wednesday afternoon session was a joint meeting with the Asphalt Paving Technologists. It was opened with a paper by J. W. Davitt on "Needed Improvements on Paving Plant Equipment and Methods." The discussion on this paper was opened by H. C. McClure, city engineer of Flint, Mich. "Machine Finishing for Hot-Mixed Pavements in California," by C. S. Pope, chief construction engineer of the California Highway Department; "Resurfacing Concrete Roads With Asphalt

When you want catalogs—consult the *classified* INDUSTRIAL LITERATURE section, page 61

Wearing Surfaces," by W. H. Sharp, engineer of repairs of the Connecticut Highway Department, and "Rough Texture Asphalt Pavements in Europe," by F. J. Le Duc, head of the Municipal Testing Laboratory of Montreal, were other interesting papers at this session.

The Wednesday evening session was under the direction of the asphalt paving technologists, and covered "Causes, Correction and Prevention of Checking in Asphalt Paving Mixtures," by Henry L. Howe, city engineer of Rochester, N. Y. This was a report of a committee of which Mr. Howe was chairman. There followed a discussion of the types, characteristics and uses of emulsions, which was participated in by Lester Kirschbraun of Flintkote Roads, Inc.; C. N. Forrest of the Barber Asphalt Co.; E. S. Ross of the Headley Emulsified Products Co.; and C. L. McKesson of the Bitumuls Co. The next topic, "Cold Laid Mixtures," was discussed by Gene Abson, the Chicago Paving Laboratory; Edmund Johnstone, Colprovia Roads; Gen. C. C. Jamieson, Asfalterra Co.; O. H. Berger, Macasphalt Co.; and W. C. West, the West Process Co.

Thursday was given over to airport paving, and the three papers presented were: "Standard Paving for Airports," by R. H. Simpson, chief engineer, Department of Public Service of Columbus, O.; "The Experimental Runway Construction at Lambert-St. Louis Municipal Airport," by Mark R. Thompson, Board of Public Service, St. Louis; and "Oiled Runways" by John A. Herlihy, of the Transcontinental Air Transport, St. Louis.

There was to have been an inspection trip Thursday afternoon to see the retread construction described by Mr. Hinkle, but since this work is all in the northern part of the state, this portion of the program was modified to allow for inspection of other work.

Missouri Valley Section, Am. Water Works Ass'n

This section held a meeting at Sioux Falls, S. D., November 6 to 8, at which a number of papers were discussed and the following officers elected: chairman, Thomas D. Samuel, Jr.; vice-chairman, H. V. Pedersen; director for the A. W. W. A., T. J. Skinker; state representatives on the board of the section—for Iowa, J. Chris Jensen; for Kansas, W. L. Brown; for Missouri, W. Scott Johnson; for Nebraska, D. L. Erickson; for South Dakota, J. S. Nelson.

Papers were read by Prof. Earle L. Waterman, describing how a series of accidents caused a shut-down of the Albany plant last summer; C. H. Koyl described the progress made by railroad water chemists and engineers in softening boiler water; Waldo W. Towne read a paper entitled "Characteristics of South Dakota Water Supplies;" R. E. Bragstad described the new sewage treatment plant at Sioux Falls, in which digestion tanks are heated by means of the gases generated therein; and E. B. Black described the water filter plant under construction at Tulsa, Okla.

The South Carolina Society of Engineers

A society was organized with the above name in Columbia on November 7, and expects to hold a meeting in January. Harwood Beebe of Spartanburg was elected president, John McCrady of Charleston as vice-president, L. A. Emerson of Columbia as secretary-treasurer, and Dean S. B. Earle of Clemson College, member of the board of directors for the northwestern district, T. Keith Legare for the central district, and J. E. Gibson of Charleston for the southeastern district.

Government Reports

The United States Coast and Geodetic Survey, Its Work, Methods and Organization.—The publication bearing the above title describes in considerable detail the work, methods, and organization of this branch of the Government service. This publication, which is issued free of charge, was prepared with the purpose in mind of acquainting the public with the various services being performed by this bureau and with the benefits derived therefrom by the engineer, the scientist, the mariner, and others.

The following table of chapter titles shows the scope of the publication: Introductory, astronomic work, base lines, triangulation, first order traverse, topography, hydrography, tides, currents, terrestrial magnetism, nautical charts, coast pilots, oceanography, leveling, seismology, gravity, geodesy, or the measurement of the earth, original records and data.

Manual of First-Order Leveling.—This publication contains the general instructions, revised to date of issue, and the summarization of the methods employed by the Coast and Geodetic Survey in executing first-order leveling and in making the office computations relating thereto. An endeavor has been made to collect from all available sources material that will be of use to the field engineer or the office mathematician who may be assigned to this class of work.

While written particularly to meet the needs of the Coast and Geodetic Survey, the treatment of the subject is such that the publication should be of value to all engineers interested in precise leveling work or in the results obtained therefrom.

The scope of the publication is best shown by its table of contents:

Part 1.—Field Methods

Introduction.
  Resolution of the International Geodetic Association.
General instructions for first-order leveling:
  Methods.
  Determination of collimation error.
  Length of sights.
  Allowable divergence of runnings.
  Rejections.
  Mistakes.
  Program of observing.
  Permanent bench marks.
  Designations of bench marks.
  Descriptions of bench marks.
  Records and computations.
  Miscellaneous.
Instruments:
  Geodetic level.
  Adjustment of geodetic level.
    Determination of stadia interval.
  Rods.
    Turning points.
  Care of level and rods.
Organization and equipment of party:
  Instruments and outfit.
Management of party and procedure in field.
Errors of leveling:
  Mistakes or blunders:
  Accidental and systematic errors.
  Errors due to atmospheric conditions.
  Systematic errors on slopes.
Bench marks:
  Permanent bench marks:
    Standard concrete bench marks.
  Supplementary bench marks.
Descriptions of bench marks:
  Permanent bench marks.
  Recovered bench marks.
  Supplementary bench marks.
Instructions for river crossings.
Instructions for stamping elevations on bench marks.
Season's report.
Field records and computations.

Part II.—Office Computations

Checking field data.
Corrections.
  Orthometric and dynamic corrections.
  Corrections for collimation and for curvature and refraction.
Adjustment of elevations.
  Case I:
    First method.
    Second method.
  Case II:
    First method.
    Second method.

TABLES

I. Allowable divergence between backward and forward runnings of a section.
II. Total correction for curvature and refraction.
III. Differential correction for curvature and refraction.
IV. Orthometric and dynamic corrections.
V. Conversion tables (feet to meters and meters to feet).
Index.

The publication contains eighteen illustrations. It is sold only by the Superintendent of Documents, Government Printing Office, Washington, D. C. The sale price is 30 cents.

Trade Publications

Lorain Locomotive Cranes. — The Thew Shovel Co., Lorain, O., has brought out a valuable bulletin describing its 15 and 20-ton Lorain locomotive cranes, powered with gasoline, electric or Diesel motors.

Caterpillars. — Approximately 350 unretouched action pictures of actual jobs the world over appear in series of eight booklets, dealing with the use of "Caterpillar" Tractors in industry, recently published by the Caterpillar Tractor Co., San Leandro, Calif., and Peoria, Ill. There is scarcely a major industry which is not represented in the pages of these eight booklets. Oil, mining, manufacturing, power and light, maintaining golf courses and airports, contracting, railroading, or what-have-you—you are almost sure to see some phase of it handled by "Caterpillars" in the pages of

these booklets. Here are the titles: "Public Service and Utilities," "Traction for Manufacturing," "Moving Things," "Mines, Quarries, Clay Plants," "Oil Industry," "Improving and Maintaining Airports, Cemeteries, Golf Courses, etc.," and "Maneuverability and Non-Slip Traction." Write for copies.

Tractors.—The Caterpillar Tractor Co., San Leandro, Calif., have published some new literature describing additional economical uses of Caterpillars, which they will be glad to send on request.

Road Graders.—The Austin Giant 8-foot straight wheel grader is described in Bulletin 1081; and the Standard 7-foot straight wheel grader in Bulletin 1082. Published by the Austin-Western Road Machinery Co., 400 N. Michigan Ave., Chicago, Ill.

Diesel Engines.—An attractive, 24-page catalog describing their new Vertical Diesel Engine has been placed in the mail by The Buckeye Machine Company, of Lima, Ohio. Additional copies are available to anyone interested at no cost or obligation.

Buckets.—Page buckets for all uses from ⅜ to 10 cubic yards capacity are described in detail in Bulletin 400 (buckets ⅜ to 2 yards) and 500 (from 2½ to 10 yards). Page Engineering Co., 844 Rush street, Chicago, Ill.

Strand Elevating Grader.—An illustrated folder discribing the new improved Strand elevating grader published by J. D. Adams Co., Indianapolis, Ind.

Civil Service

Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

Topographic Draftsmen.—Applications for *Principal Topographic Draftsman,* $2,300 a year; *Senior Topographic Draftsman,* $2,000 a year; *Topographic Draftsman,* $1,800 a year; *Assistant Topographic Draftsman,* $1,620 a year; *Junior Topographic Draftsman,* $1,400 a year, must be on file with the Civil Service Commission at Washington, D. C., not later than December 18. The examinations are to fill vacancies in the Departmental Service, Washington, D. C., and in positions requiring similar qualifications throughout the United States. Higher salaried positions are filled through promotion.

Competitors will not be required to report for examination at any place, but will be rated on their education, experience, and fitness, and on topographic drawing and lettering.

Junior Engineer.—Applications for Junior Engineer, entrance salary $2,000, must be on file with the Civil Service Commission at Washington, D. C., not later than February 4, 1930.

The examination is to fill vacancies in various branches of the service throughout the United States.

The optional subjects are (1) aeronautical engineering, (2) agricultural engineering, (3) chemical engineering, (4) civil engineering, (5) electrical engineering, (6) mechanical engineering, (7) mining engineering, (8) naval architecture and marine engineering, and (9) structural steel and concrete engineering.

The duties are to perform routine testing, inspection of engineering material, drawing up plans for minor projects, preparing specifications for engineering material or apparatus, performing field work, making computations, preparing maps, assisting in conduct of experimental research tests, compiling reports, and handling technical correspondence.

Competitors will be rated on general physics, mathematics, general engineering, and the optional subjects chosen from those named above.

Senior students will be admitted to the examination.

Industrial Notes

Fruehauf Trailer Acquires Warner Mfg. Co.

Through Harvey C. Fruehauf, president, the Fruehauf Trailer Company, of Detroit, announces acquisition of the control of the Warner Manufacturing Company of Beloit, Wisconsin. The Warner Company is one of the oldest trailer manufacturers in the country, well established in the hauling field and maintaining distributors in more than twenty of the principal cities of this country. It will continue to operate as an independent unit with the same management and sales personnel as before, but its headquarters will be moved to Detroit at once, and all administration and production activities will be carried on there after November 15th of this year.

This step marks the amalgamation of the two oldest trailer manufacturing concerns in the United States, and places the Fruehauf Company in a very strong position so far as its patent situation is concerned. Further, it is felt that trailer users will realize substanial benefit from this pooling of resources, equipment and executive experience.

McKiernan-Terry Corporation

The well known McKiernan-Terry Drill Company, of 15 Park Row, New York, on November first changed its corporate name to McKiernan-Terry Corporation and acquired ownership of The National Hoisting Engine Company, of Harrison, New Jersey, and Steele & Condict, Inc., of Jersey City, New Jersey. The consolidation of these three firms with products going into the same fields has been effected to provide adequately for greater business expansion.

The National Hoisting Engine Company and Steele & Condict, Inc., will preserve their identity to the extent that they will operate and be known as divisions of the McKiernan-Terry Corporation, but with executive activities transferred to the sales offices of the corporation in New York.

The officers of the McKiernan-Terry Corporation are: Arthur W. Buttenheim, president; Lester H. Buttenheim, vice-president in charge of production; Charles S. Ackley, vice-president in charge of sales; William F. Campbell, vice-president in charge of national hoist division; John C. Smaltz, vice-president in charge of Steele & Condict division; Earle R. Evans, vice-president in charge of field operations; Thomas E. Sturtevant, treasurer; Samuel Harper, assistant treasurer; Samuel Whitehurst, secretary; J. Forrester Campbell, assistant secretary.

For economic reasons, work previously done at the plant of Steele & Condict, Inc., at Jersey City, will be transferred to, and divided between, the McKiernan-Terry plant at Dover, N. J., and The National Hoisting Engine plant at Harrison, N. J.; both of which plants have already been substantially enlarged and further building expansion and increases of tool equipment are pending.

Headley Emulsified Products Co.

The Headley Emulsified Products Company, on October first, became the successor to Headley Good Roads Company of Philadelphia, which for 21 years have manufactured emulsified asphalt products. The new company will expand this line to cover all of the following industrial uses: highway construction and maintenance, railroad platforms and crossings, waterproofing, dampproofing and protective coatings for all types of structures.

The officers of the new corporation are: President, Edgar S. Ross, director of research and development of the old company, and formerly in charge of investigations on roofings and waterproofings at the Mellon Institute of Industrial Research; vice-president, Parmely W. Herrick, of the Herrick Company, Cleveland, Ohio; vice-president and treasurer, M. W. Lefever, for 15 years in a similar position with the Headley Good Roads Company; secretary, George D. Webster, Esq., of Cleveland.

The present plant at Marcus Hook, Pa., will be supplemented by other manufacturing facilities to be located at points not yet determined. Branch offices in charge of resident engineers will be opened in a number of cities, and distributors with warehouse stocks are to be appointed in the leading industrial centers.

When you want catalogs—consult the *classified* INDUSTRIAL LITERATURE section, page 61

Engineering and Construction Equipment

New Machinery, Apparatus, Materials and Methods and Recent Installations.

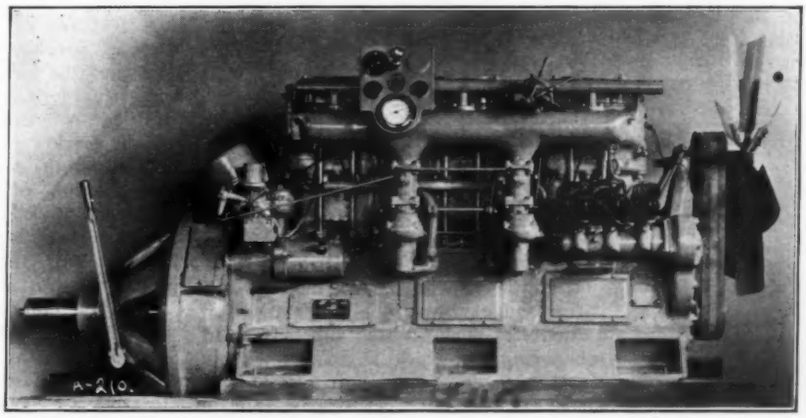
Sterling Engine Company's Power Show Exhibit

The sterling Engine Company will exhibit at the Power Show three engines, including one of their large Viking II 8-cylinder engines, probably the largest bore 8-cylinder gasoline engine and most powerful employed for stationary duty. With 8-inch bore and 9-inch stroke, 565 h.p. is delivered at 1200 revolutions. The actual load is usually about 500 h.p. This is a duplicate of the engine being installed on the Pennsylvania Lehigh Bridge of Newark Bay, and is similar to the engine installed at Oshawa, Ontario, for driving a centrifugal pump. One at the water works at East Chicago, Indiana, embraces an installation with two clutches arranged so that the engine can drive a pump off one end and a generator off the other.

The Sterling Dolphin 6-cylinder engine has long been a most successful engine and is used for a variety of duty. Both the Viking and the Dolphin models represent dual valves in the head, allowing 50% more valve area than any engine not so constructed. Counter-weighted and dynamically balanced crank shafts reduce bearing loads 55%. A very unique type of aluminum piston, in use since 1922, contributes to the success of the engines.

These three items are the outstanding features of Sterling engines, which are used for driving centrifugal pumps, electric generators, and air compressors; for operating bridges, delivering water for fire and domestic service, furnishing current for lights, elevators and plant operation, and general employment on duty requiring high horsepower and fairly continuous operation, direct-connected at 1200 r.p.m.

In addition to the Viking and Dolphin, a smaller model, the Petrel, will be exhibited at the Power Show, Booth No. 50, in charge of M. E. Mutchler, general sales manager. C. A. Criqui, president, C. A. Criqui, Jr., treasurer, and a representative of the engineering staff will be at the booth also.



STERLING-DOLPHIN SIX-CYLINDER ENGINE; 225 H. P., 1550 R. P. M. Usually twin carburetors arranged combined with triple ignition affords extraordinary power for a 5¾-inch bore engine

"United" Announces Industrial Tractor and Equipment Lines

A complete line of tractor powered road-building and construction equipment has recently been announced by the United Tractor & Equipment Corporation, of Chicago, an organization formed over a year ago by a number of well-known equipment manufacturers and distributors who have since been busily engaged in the development of their equipment lines.

The "United" industrial tractor, around which all the operating equipment is designed, is built by the Allis-Chalmers Mfg. Co. at the Milwaukee plant. To make the tractor available for the widest possible range of work, it is furnished as either a rubber-tired or a crawler tractor unit.

Included in the United line are: The rubber-tired industrial tractor, the crawler tractor, road graders and rollers, snow plows, power shovels, "iron mules," scrapers, bulldozers, backfillers, loaders, hoists, arc welders, cranes, pipe-handling booms, locomotives, stump-pullers, trailers and street sweepers. A representative showing of the line will be made for the first time at the Atlantic City Road Show in January.

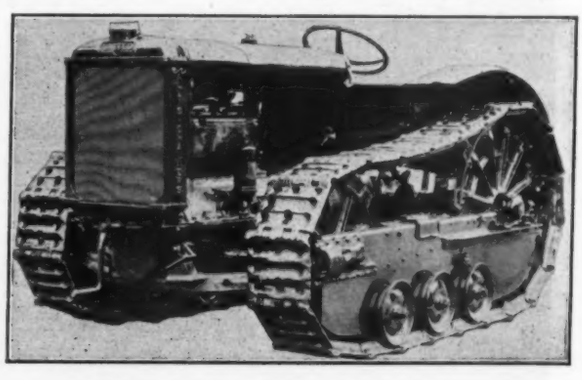
The "United" tractor combines unusual power with light weight and sturdy, compact construction. Among other features claimed for it are great power at all engine speeds, ease of handling and economy in operation. Frameless, single-unit type of construction with three-point suspension is employed, with all gears and working parts enclosed.

The power plant is a heavy-duty four-cylinder engine with a 4 1-4-inch bore and 5-inch stroke. Under full load the engine speed is 1200 r.p.m. and is under built-in governor control. A gear-driven oil pump with leads to all main bearings, connecting-rod bearings and piston pins, provides full pressure lubrication. The engine is protected against dust by a double-action air cleaner and an oil purolator.

The transmission is of the automotive unit power plant type, and provides four forward speeds and reverse. Speeds available at normal engine speed are 2 1-3, 3 1-3, 5 and 10 miles an hour.

Several thousand "United" tractors

"UNITED" CENTER CONTROL GRADER
Built by Wehr Co., powered by "United" tractor

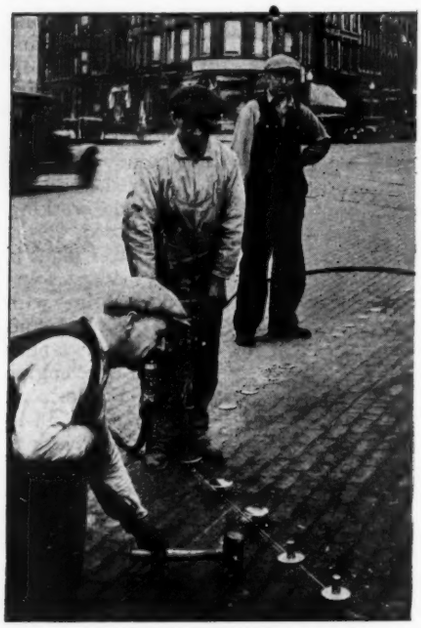


"UNITED" CRAWLER TRACTOR
Joint product of Allis-Chalmers and Trackson Company

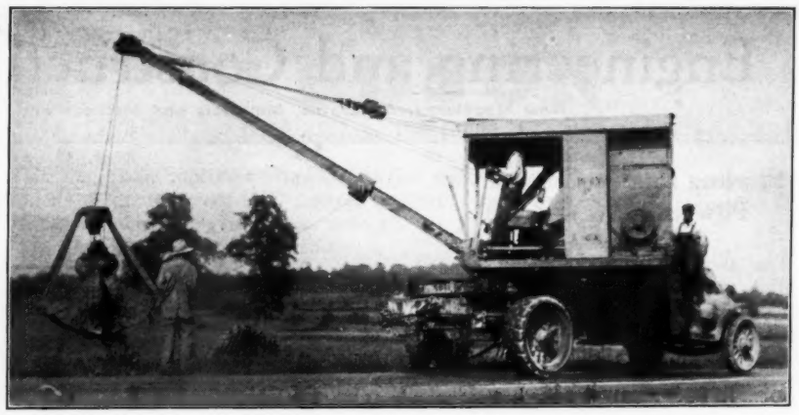
are in actual use in various fields, including a number in the service of state highway departments. The design of all operating equipment for the tractor embodies proven features developed over a period of years by the individual manufacturers of the corporation.

Included in the list of corporation members manufacturing United industrial equipment are: Allis-Chalmers Mfg. Co., Milwaukee, Wis.; Brookville Locomotive Co., Brookville, Pa.; Detroit Harvester Co., Detroit, Mich.; Dorsey Bros., Elba, Ala.; Maine Steel Products Co., South Portland, Me.; Muskogee Iron Works, Muskogee, Okla.; Northwestern Mfg. Co., Milwaukee, Wis.; Perry Co., Sidney, Ohio; The Hughes-Keenan Co., Mansfield, Ohio; Trackson Co., Milwaukee, Wis.; Universal Power Shovel Co., Milwaukee, Wis.; Wehr Co., Milwaukee, Wis.

The sale and service of United tractors and equipment is handled through distributing members of the corporation and their affiliated dealers.



SETTING SCOVILL MARKERS



UNIVERSAL CRANE ON OHIO STATE HIGHWAY

Universal Cranes in Ohio

The Ohio State Highway Department operates eleven Universal cranes similar to the one illustrated for general road maintenance and construction work, such as unloading cars to trucks or stock piles, cleaning out ditches and building new berms, bridge construction and culvert building. Because of their ability to reach a job quickly, they find a special field in clearing roads of slips and landslides, which occur frequently in the southern part of the state.

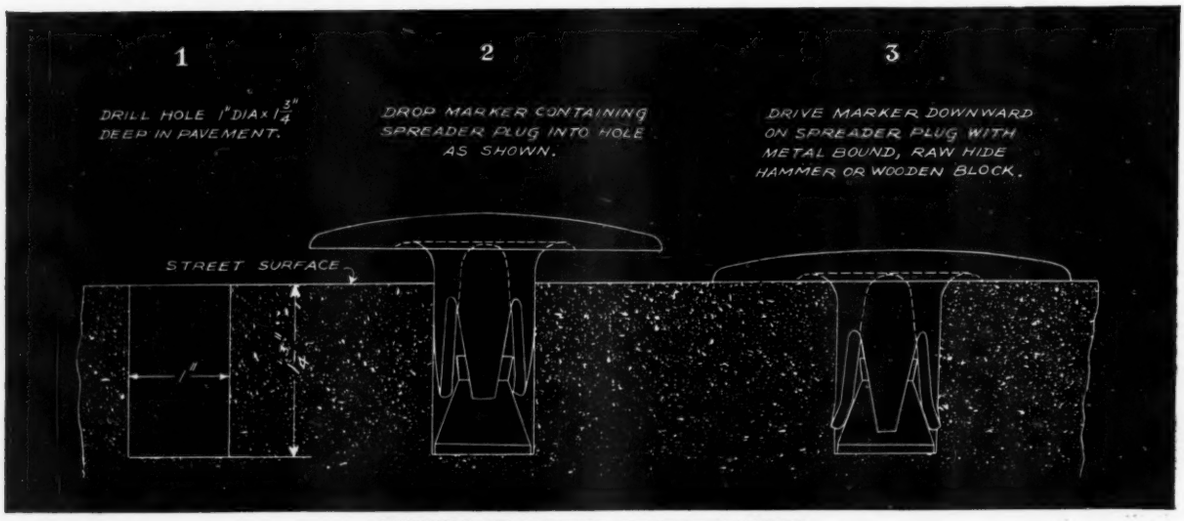
The system employed is to place one or more of these cranes with each division engineer, who details them to the various supervisors in his territory for a definite period; the supervisor so scheduling his work as to get all his crane work done during that time. On emergency jobs the crane may have to travel clear across the division over night.

Twenty-four Model LH Trackson McCormick-Deerings equipped with one-man graders of various makes were ordered recently by the State Highway Department of Texas, for road construction and maintenance operations. Of these eight will be equipped with Gilbert Graders, eight with Adams, and the remainder with Stockland Whippets.

Scovill Stop Spot Traffic Markers

The Scovill Manufacturing Company of Waterbury, Conn., manufacture Scovill Stop Spot Markers which combine the features of visibility, permanence, ease of installation and economy. Because of the iron expander construction these markers remain permanently imbedded wherever installed; the grip of the marker prongs minimizes loosening under the severest conditions. The construction of the marker itself is such that it resists pressure from traffic, without breaking the head from the stem. This feature, unlike the more brittle type of marker, permits peaning down the outer rim so that the outer edge snugly hugs the pavement. Being of cast brass, there are no sheet metal shells formed over the surface to chip, or loosen, and thus cause the tripping of pedestrians or damage to automobile tires.

A row of Scovill stop spot traffic markers, because of their size and color, create the illusion that the markers are raised much higher from the street than they really are. This makes for marked visibility. Of equal interest, is the fact that these markers are always visible from a distance. Being of brass, the action of tire traffic keeps them constantly bright and contrasts them to the color of the pavement.



DETAILS OF SCOVILL STREET MARKER

These markers will never rust, corrode or lose their visibility, it is claimed.

The markers are quickly installed, and in a manner requiring a minimum number of unskilled workers. For wood blocks pavements, the only equipment necessary is a rotary drill and the hammers. A steel plug or expander is an integral part of the unit, and when the marker containing the spreader plug is dropped into the drilled hole, a downward drive of the marker on the spreader plug with the hammer expands the claws of the marker and anchors it firmly and permanently.

These markers are economical not only because they eliminate the recurring expense of inadequate painted lines, which they replace, but also because they are permanent. Once they have been installed, they will serve indefinitely and efficiently.

They are also one of the surest methods of eliminating the confusion and resultant accidents that often tie up traffic at congested street corners.

W-K-M Boom

The W-K-M Company, Inc., of Houston, Tex., is offering to contractors, as one of its latest products, a boom to be attached to Caterpillar tractors "Standard 20," "Standard 30," "Hillside Special 30" and "Standard 60" for handling, hauling, digging, etc. The W-K-M boom in no way hampers the use of the tractor on drawbar work. It can be used in connection with a clamshell, dragline or throwout bucket, lifting magnet, etc., doing most of the work commonly performed by machines expressly manufactured for these purposes.

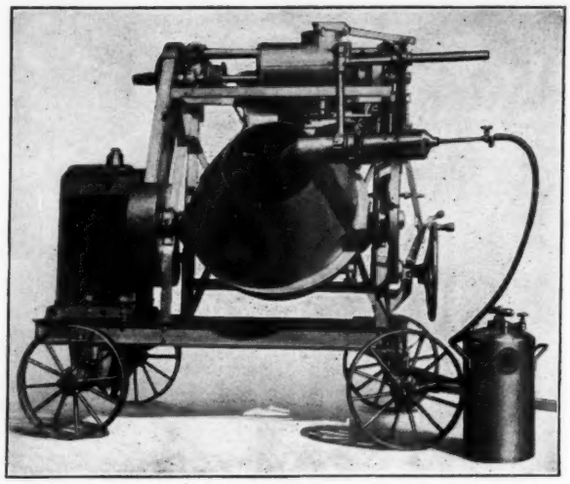
The unit incorporates most of the characteristics commonly found in all cranes, except that it utilizes the power generated by the tractor. A lateral boom swing of 90 degrees is obtained through the use of two small swing winches. In addition, a low-speed and a high-speed winch are provided, either drum of which can be changed in a very short time to obtain the same speed in both winches.

W-K-M BOOM ATTACHED TO TRACTOR

The method of attachment is very simple. No drilling or cutting of any kind is required. Four clamps are provided, two being attached to the track roller assembly on each side of the tractor. The winch and boom mechanism are mounted on a heavy channel shelf, which is attached to the clamps on the left-hand side of the tractor by means of pins. A counterweight shelf, provided for attachment to the right-hand side of the tractor, is fastened in the same manner. This method of attachment permits quick assembly, or disassembly provided it is desired to take the equipment from the tractor.

Power is obtained from the rear of the tractor by means of a specially designed power take-off unit and is passed to the main shaft by means of heavy chains. This main shaft is of high-grade steel, accurately machined, and is provided with large-size keyways to prevent shearing or rolling of keys. The main bearings are of babbitt, while the countershaft and drum bearings are of bronze.

Clutches are of the internal expanding type 17½ inches in diameter. The shoes are faced with composition lining which can be renewed easily without removing or disturbing other parts on the shaft.



LITTLEFORD HEATER FOR MIXERS

Only the best grade of steel castings is used throughout. "A" frames are provided on each side of the tractor, connected by a cross brace, thereby eliminating all strain on the track roller frames and final drive bearings. In order to overcome the strain on the equipment through the track oscillations, the manufacturers have provided ball and socket joints wherever necessary.

A collapsible boom is provided having a normal length of 13 feet. When extended it has a length of 25 feet. The diameter of the outside pipe is 5 inches and that of the inside, 4 inches.

Universal Heating Attachment for Concrete Mixers

Littleford Bros. have developed something new in the way of a universal concrete heater attachment for tilting drum mixers. It clamps on any angle or flat iron brace on the mixer and can be perfectly adjusted in less than five minutes. There are no holes to drill or brackets to fit—it is necessary only to tighten two set screws and the attachment is on as though it were a part of the mixer. The installation shown is typical of the outfit placed on any tilting drum mixer having a capacity of five cubic feet or over.

Truscon Welded Steel Fabric,

This fabric, which has been standard reinforcement for concrete highways in a number of States for several years, has recently been made available in sizes and weights suitable for general reinforcing work. A special booklet put out by the Truscon Steel Company, of Youngstown, Ohio, contains a general description of this new product, with tables of standard types and sizes, properties of the wire used and sectional areas of the fabric, allowable load capacities for floor slabs of various spans, a tentative schedule of specifications for reinforced concrete sewer pipe, and

tables for estimating weight per hundred square feet of welded steel fabric.

The makers expect this new product to be used in the construction of docks, bridges, levees, floor slabs, reservoirs, driveways, sewers, subways, stadiums, viaducts, flues, grandstands, pipe, sidewalks and seawalls.

The fabric comes with four-inch mesh, the main wires and cross wires being welded by an electrical process which results in positive fusion of the two wires. It is shipped in coils or sheets in weights up to ninety-seven pounds per 100 square feet. The booklet above referred to cites recognition of welded steel fabric by the New York City building code, which allows stresses about 25 percent higher when welded steel fabric is used as floor reinforcement. The booklet also contains descriptions of Truscon road forms, curb bars, rib reinforcing bars and other Truscon concrete reinforcing products.

Detroit Four-Wheel Trailer

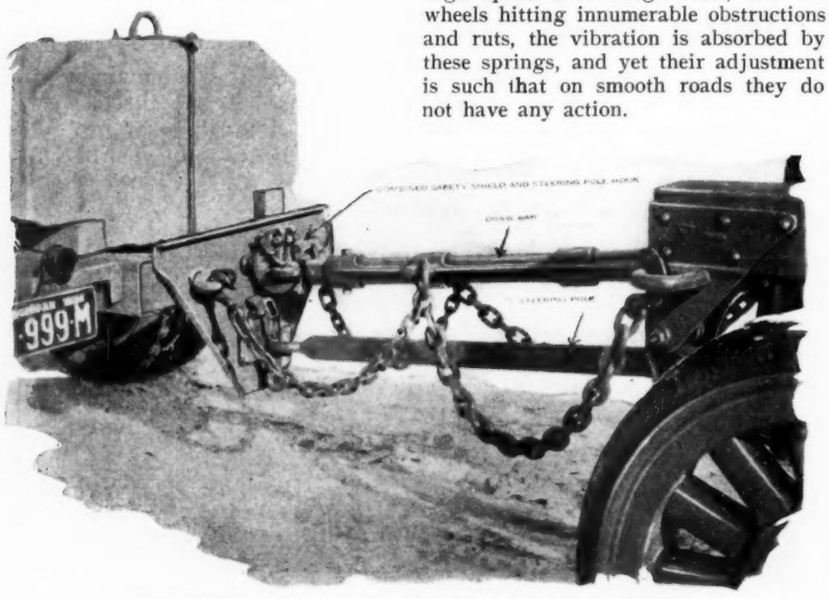
The Detroit Trailer & Machine Co., of Detroit, Mich., has brought out a new Model K four-wheel trailer, with live or knuckle-type axles with four points of suspension. The company guarantees that, compared with the circle or fifth-wheel type of trailer, its Model K, with equal pay load, has a gross weight at least 10% less, or will carry at least 10% more pay load with equal gross weight; that the draw-bar pull is at least 10% less, resulting in a marked saving in gasoline (in one case 20%); that it will not sway when either new or old, unless it has been subjected to gross neglect, and probably not then; that it will run true, even though pulled by chains only; that it can be coupled to a truck more safely, because of the safety shield, draw-bar and steering pole arrangement; and that when being backed with the rear end in live action, it can be handled with safety by one man under almost any condition.

The draw-bar has an eye at each end, one being attached to the hook on the first cross member on the trailer, the other to the hook on the truck.

All the strain in moving the trailer is taken care of by this simple bar without disturbing the steering unit; its flexibility in hooking up cannot be surpassed.

The steering pole has only one duty to perform; viz., to guide the trailer. The main pivotal point on the axle is controlled by adjustable taper bearings and relieve these bearings of unusual strain. The steering assembly swings on a half-circle sector which is fastened to the axle. The slightest action is controlled by this sector, which is made more than strong enough to withstand any strain that can possibly be put upon it. The yoke pivotal points are 16 inches apart, each 2½ inches and bronze bushed. Should the trailer not be greased for years, there could not be enough looseness set up at these points to affect the steering.

The rear steering arms are attached both above and below the tie rod to a block which has a sliding action on the tie rod and presses against springs on each side. Should a severe steering strain come on a wheel, the spring on the tie rod would compress and relieve the shock or strain. When running at high speed over rough road, and the wheels hitting innumerable obstructions and ruts, the vibration is absorbed by these springs, and yet their adjustment is such that on smooth roads they do not have any action.

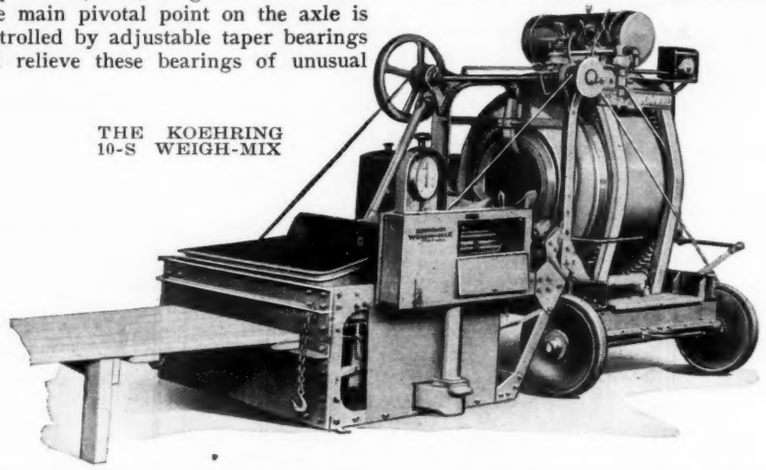


STEERING POLE OF DETROIT MODEL K TRAILER

Koehring Brings Out a 10-S Weigh-Mix

The Koehring Company, Milwaukee, Wisc., have combined the 10-S Dandie mixer with a weighing device to bring out the Koehring 10-S Weigh-Mix.

Designed for the jobs requiring concrete of pre-determined strength, the Koehring 10-S Dandie Weigh-Mix accurately proportions aggregates by weight and water by volume. It meets every requirement of accuracy in proportioning and speed in operation together with extreme portability, and provides an ideal unit for weighing and mixing on the job.



THE KOEHRING 10-S WEIGH-MIX

The weighing device consists of a 2,500 pound all-metal platform scale, a cradle to carry the scale and receive the skip; a saddle to protect the scale from the possibility of a dropped skip; a vibrator for cleaning the skip quickly and thoroughly; and a trailer providing easy, quick transportation from job to job.

Each material — cement, sand and stone — is weighed separately on the three-beam scale. The water is measured by an accurate volume water measuring tank. The desired weight of stone is set on the stone beam and the weight of sand and cement on their beam, all materials being weighed in the skip. An indicator dial registers when the material being measured is nearing the desired weight on the beam.

The skip is cleaned automatically by a vibrator as the materials are being shot into the drum during charging. With this device the charging action is speeded up and a clean skip is provided for each batch.

When moving the 10-S Weigh-Mix from job to job, a two-wheeled rubber-tired trailer is attached to the mixer for carrying the scale and cradle. It is only a matter of minutes to detach the trailer, lower the scale and cradle to the ground, and level properly. The machine is then ready for mixing.

The mixer operator controls charging as well as mixing and discharging, all operations being centralized in his control. Speed in weighing is aided by use of the double faced indicator dial, with a pointer in full view of the shovelers, inspector and operator.

New "64" and "68" Tread Center-Drive Crawler

New improved Center Drive Crawlers are announced by the Thew Shovel Company, Lorain, Ohio, for its ¾ yd. Lorain-45, 1 yd. Lorain-55 and 1¼ yd. Lorain-75. The most radical development is represented by the new "64" and "68" Tread Crawlers. The numerical designation of the crawlers comes from the number of treads in the self-laying tracks. These crawler mountings are available for the Lorain-45, 55 and 75 cranes, clams, drags and back-diggers and offer a modern development in crawler design and operation.

Basically they are the standard "52" and "56" tread crawlers—plus. Instead of the standard single-end rollers, equalizer rocker arms, carrying both a large end roller and a small intermediate load-carrying roller, are mounted on the end axle. This places the large end rollers in advance of the end axle and increases the overall length from 12% to 29% on the various units. The resulting greater supporting area also gives reductions of ground pressures that average from 15% to 25%.

In addition to the materially reduced ground pressures, the action of the equalizer rocker arm is such that the tendency to "dig-in" is eliminated. Any tipping load thrown onto the end axle is transmitted down through the rocker arm and its two rollers and is distributed by them over an increased area of several treads. This effects uniform lower ground pressures and eliminates the concentrated pressures that cause digging-in at the ends.

The distribution of the end axle load to its rollers is such that the smaller or rear roller carries the greatest load, the effect on the front end roller being to climb or nose-out of soft materials.

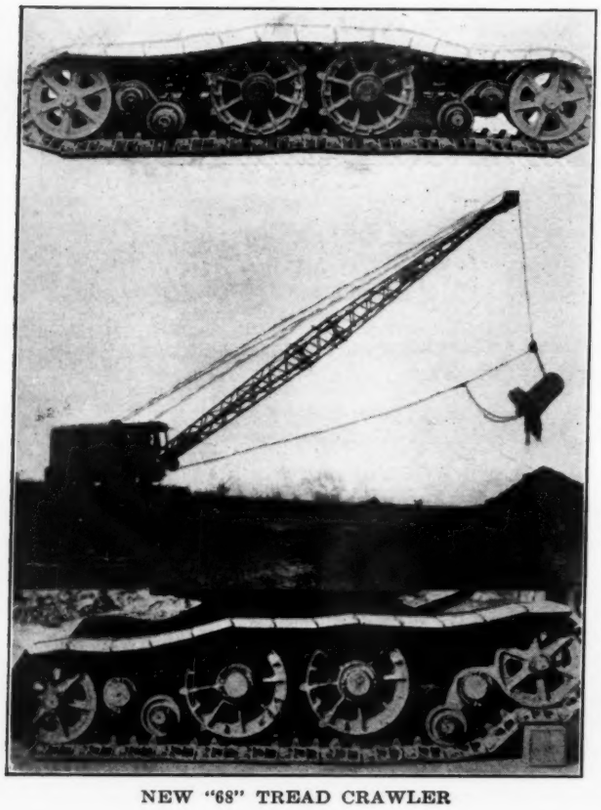
The equalizer rocker arm action in this respect is well illustrated by the traveling action of the crawler. The up-and-down action of the equalizer rocker arm (prevented from reversing by an automatic stop) enables the crawler tread to self-adjust itself to the contour of the terrain without "bridging" across depressions, etc.

With the equalizer rocker arms at the ends, the propulsion of the unit must come from the center; thus all the crawler units are propelled by the patented Thew center drive.

When the equalizer rocker arms are replaced with standard single-end rollers, "52" or "56" tread crawlers for the Lorain-45, 55 and 75 shovels, cranes, clams, drags and back-diggers result. For shovel use, when it is desirable to keep the shorter standard end of the crawler faced into the bank, equalizer rocker arms may be added at the rear of the crawler only.

The standard "52" and "56" crawlers are improved throughout. These improvements in general are typified by the new Lorain-75 crawler, which is 12% longer, 2300 pounds heavier, has a stronger, improved car-body casting, has 7" x 7" end axles, has 12% increased tractive effort and has steering clutches mounted on splined shafts.

Complete details of the new Center Drive Crawler are contained in a new booklet, "The 52-56-64-68 Tread Center Drive Crawler," a copy of which may be had by addressing the Thew Shovel Company, Lorain, Ohio.



NEW "68" TREAD CRAWLER

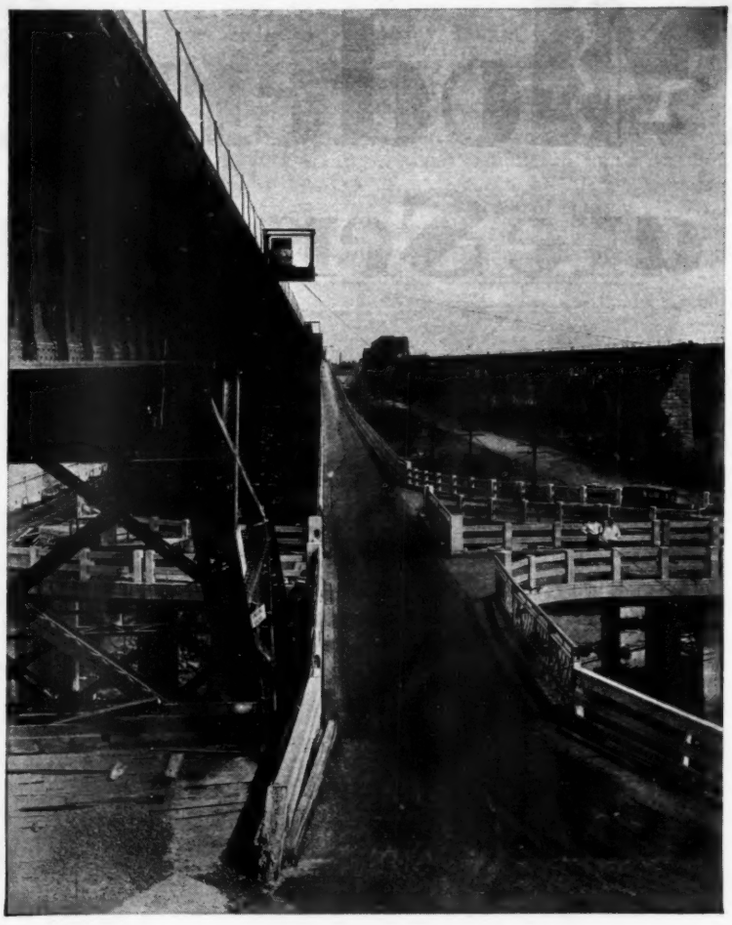
Seattle's Denny-Hill Regrade Project

In Seattle's extensive re-grading projects, about 5,000,000 cubic yards of earth have been handled, by various methods and types of equipment. W. B. Barkhuff, the chief engineer, consulted with Link-Belt engineers regarding the handling of 5,000,000 cubic yards in the Denny-Hill Regrade Project No. 2, and a system of Link-Belt anti-friction belt conveyors was worked out, which is giving eminent satisfaction to all concerned. It is moving Denny-Hill into Elliott Bay, economically, efficiently, steadily night and day, without the wear and tear of trucks on the streets, without interference with traffic, and without noise or disturbance to business or neighbors.

There are six movable field conveyors about 200 feet long, which are used in connection with power shovels and feeders, for final delivery to the inclined receiving end of a 2850-ft. overhead conveyor system. This carries 600 cubic yards of earth per hour to the end of a pier, delivering into huge self-dumping scows, to be towed out and dumped into deep water.

The contractors are George Nelson & Company of Seattle.

AT RIGHT, BELT CONVEYOR IN HOUSING. BELOW, VIEW OF ELEVATED HOUSING EXTENDING FROM HILL TO END OF PIER.



THE Harahan Bridge, at Memphis, a combination railroad and traffic structure surfaced with more than 130,000 square feet of Carey Elastite Asphalt Plank.

Like a hundred others, it has the *Elastite* kind of a floor!

THE Harahan Bridge, at Memphis, carries an enormous shuttle of traffic over the Mississippi River between Tennessee and Arkansas. Yet its surface actually seems to *thrive* under this constant traffic tattoo.

For the Harahan Bridge is floored with *Carey Elastite Asphalt Plank*—more than 130,000 square feet of it! A dense, tough composition of asphalt, fibre and mineral matter, preformed into planks of required dimensions.

Grainless, decay-proof, even-textured, indifferent to extremes in temperature. And it actually knits and heals under traffic—compresses into a surface-smooth, unified, unbroken mass. Carey Elastite Asphalt Plank is easy to install over any smooth surface, with but little interruption to traffic.

Carey Elastite

ASPHALT PLANK

. . . for Bridge Flooring

THE PHILIP CAREY COMPANY, *Lockland,* CINCINNATI, OHIO

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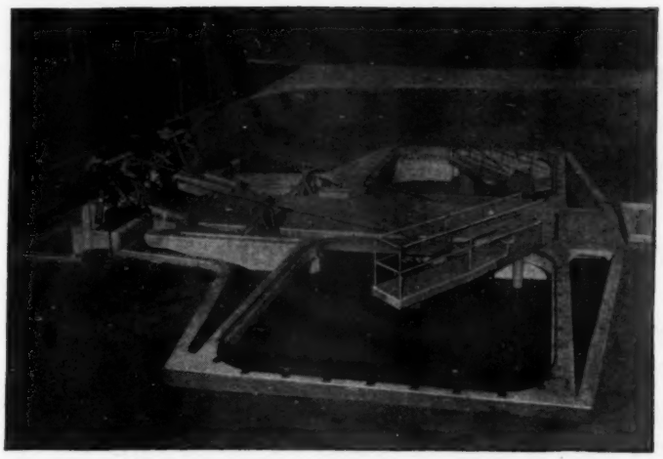
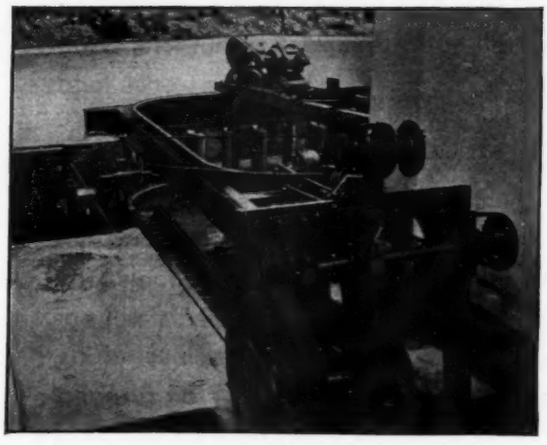


Two Dorr Detritors in the sewage treatment plant at Winston-Salem, N. C.



Washing compartment and discharging mechanism of a Dorr Detritor operating in the sewage treatment plant at Harrison, N.Y.

DORRCO

Our nearest office will gladly send you a booklet which describes the Detritor. Ask for Bulletin 6481.

Grit Removal

Important in all sewage treatment methods

GRIT, sand and other inert material are always troublesome in all sewage treatment methods. Not only does grit cause wear and abrasion on equipment in the plant but its presence is of no use in sludge digestion tanks, and in the activated sludge process it often interferes with the operation of the aeration units.

A plain, old-fashioned grit chamber can never satisfactorily keep grit from passing on to other steps in the treatment process. But a Dorr Detritor can and does in an extremely simple way.

The Detritor automatically and continuously collects the grit in the flow, washes it, and discharges it in a clean, drained condition.

Detritors can readily be installed in most existing treatment plants. Their installation improves plant operation, cuts down wear on other equipment caused by grit, and does away with the offensive conditions attendant on the intermittent cleaning out of plain grit chambers.

DENVER, COLO.
1009 17th Street
CHICAGO, ILL.
333 North Michigan Avenue
LOS ANGELES, CAL.
108 West 6th Street
WILKES BARRE, PA.
Miners Bank Building
JOPLIN, MO.
319 Joplin National Bank Building
ATLANTA, GA.
1503 Candler Building

THE DORR COMPANY
ENGINEERS
247 PARK AVENUE NEW YORK CITY

INVESTIGATION TESTS DESIGN EQUIPMENT

MELBOURNE, AUSTRALIA
Crossle & Duff Pty., Ltd., 360 Collins Street

TOKYO, JAPAN
Andrews & George Co., Inc., Central P. O. Box F-93

TORONTO, ONT.
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LONDON
The Dorr Company, Ltd.
Abford House, Wilton Rd., S. W. 1
BERLIN
Dorr Gesellschaft m. b. H.
Kielganstr, 1 W. 62
PARIS
Societe Dorr et Cie
26 Rue de la Pepiniere
JOHANNESBURG, S. A.
E. L. Bateman
Locarno House.

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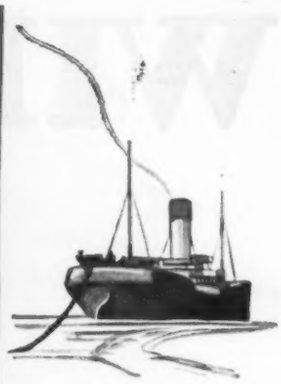
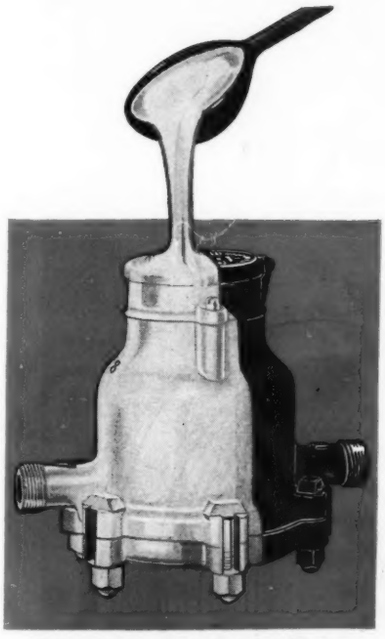


Fathoms deep lies the Trans-Atlantic cable. Over volcanic ledges, through oölitic slimes, this humming thread of life links two great continents. Millions of dollars are spent to keep the line clear. The cable is encased in armored steel, packed with tar, oakum and hard rubber. It must stand the attack of sharks, the razor edges of barnacled masses of water-logged derelicts, and the enormous force of ocean currents that drag everything in their way for hundreds of yards over an ocean bed of ledges.

Protection that defies the awesome monsters of the deep



The Hersey Disc Water Meter
is completely dipped-tinned, the best known protection against corrosion

"PROTECTION AT ALL COSTS," in water meters as in Trans-Atlantic cables, is the policy that guarantees the accuracy and service of each Hersey Water Meter. This is the dipped-tinned process. Costly?—yes. But the *only* method yet devised that will protect a meter against corrosion.

The thick coating of tin that results from the dipping process adds ten to fifteen years to the accurate life of Hersey Water Meters. Far-sighted municipalities regard dipped-tin protection as an investment for the future they cannot afford to do without.

HERSEY
WATER METERS

HERSEY MANUFACTURING COMPANY -:- *Main Office and Works:* Corner E and 2nd Streets, South Boston, Mass. *Branch Offices:* NEW YORK CITY, 290 Broadway; PORTLAND, ORE., 475 Hoyt Street; PHILADELPHIA, PA., 314 Commercial Trust Bldg.; ATLANTA, GA., 510 Haas-Howell Bldg.; DALLAS, TEX., 402 Praetorian Bldg.; CHICAGO, ILL., 10 So. LaSalle St.; SAN FRANCISCO, CAL., 690 Market St.; LOS ANGELES, CAL., 450 East Third St.

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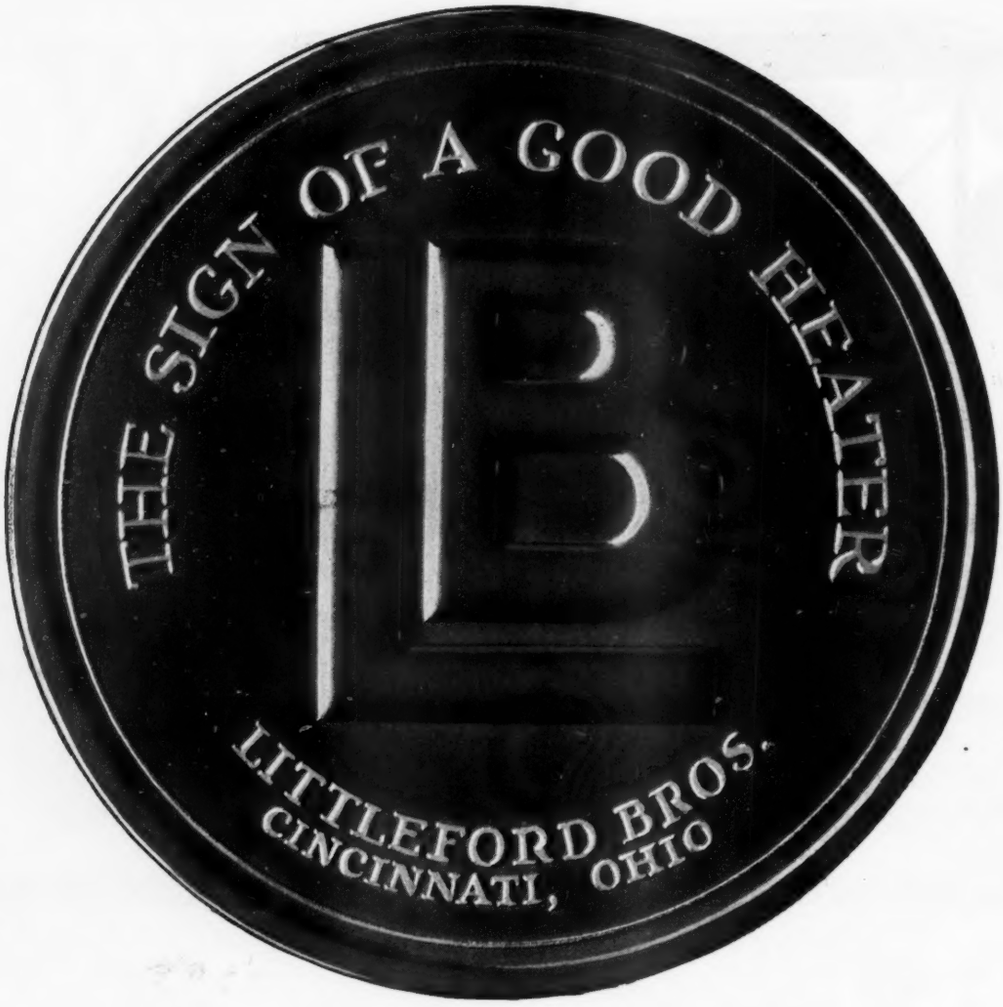

LOOK FOR THE L.B. SIGN AT THE ROAD SHOW

You'll have a real surprise at Booth 507-521. A brand new Asphalt Kettle that is unlike any you have ever seen—it's a hot outfit for maintenance work. Remember, under the L. B. sign at the A. R. B. A. Road Show—Booth No. 507-521.

LITTLEFORD BROS.

452 E. Pearl Street *Cincinnati, Ohio*

LITTLEFORD
ROAD & STREET MAINTENANCE EQUIPMENT

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When you want catalogs—consult the *classified* INDUSTRIAL LITERATURE section, page 61

What a Whale of a Difference a full Dipper Makes -

It's the load which the dipper digs that really counts in a shovel, rather than mere size or rated capacity. A full dipper at each bite does make a whale of a difference in your daily output and particularly so when your shovel is built to stand up under such service.

One of the many satisfied users of Industrial Brownhoist Shovels writes, "Our yard and one-eighth shovel is mining more than twelve hundred square yards of lime rock daily. We can recommend these shovels to anyone whose work calls for high class, efficient and substantial equipment and we consider them the best we have seen in our many years of experience."

Industrial Brownhoist manufactures the type of shovel best suited to your needs—capacities range from ½ to 1¼-yard dippers.

Industrial Brownhoist Corporation, General Offices, Cleveland, Ohio

District Offices: New York, Philadelphia, Pittsburgh, Detroit, Chicago, New Orleans, San Francisco, Cleveland.
Plants: Brownhoist Division, Cleveland; Industrial Division, Bay City, Michigan; Elyria Foundry Division, Elyria, Ohio.

INDUSTRIAL BROWNHOIST

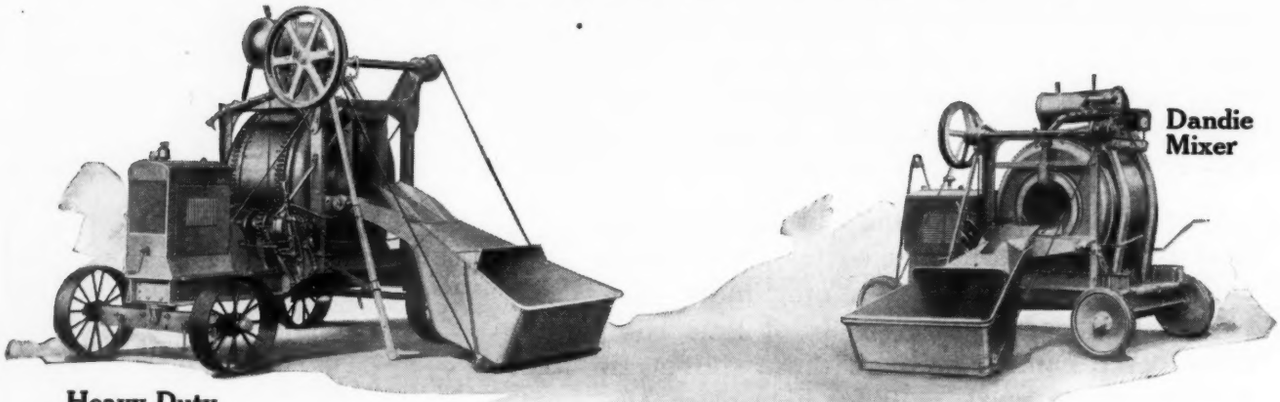
KOEHRING

KOEHRING experience, Koehring Heavy Duty construction, are two of the greatest profit factors you can put on the job!

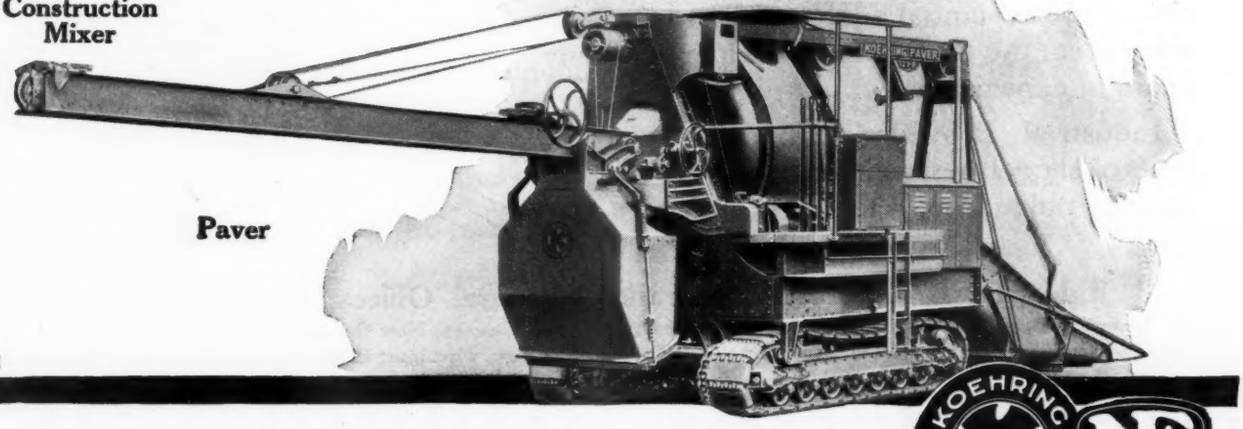
Koehring equipment is sold through organizations that are *service* as well as sales organizations!

Again we say *"Know the Koehring!"*

Write for Bulletin No. 14 on any of the machines interested in.



Heavy Duty Construction Mixer



A4710-I

KOEHRING COMPANY MILWAUKEE, WISCONSIN

PAVERS, MIXERS — GASOLINE SHOVELS, PULL SHOVELS, CRANES AND DRAGLINES

Sales Offices and Service Warehouses in all principal cities
Foreign Department, Room 579, 50 Church Street, New York City
Division of National Equipment Corporation

KOEHRING HEAVY DUTY

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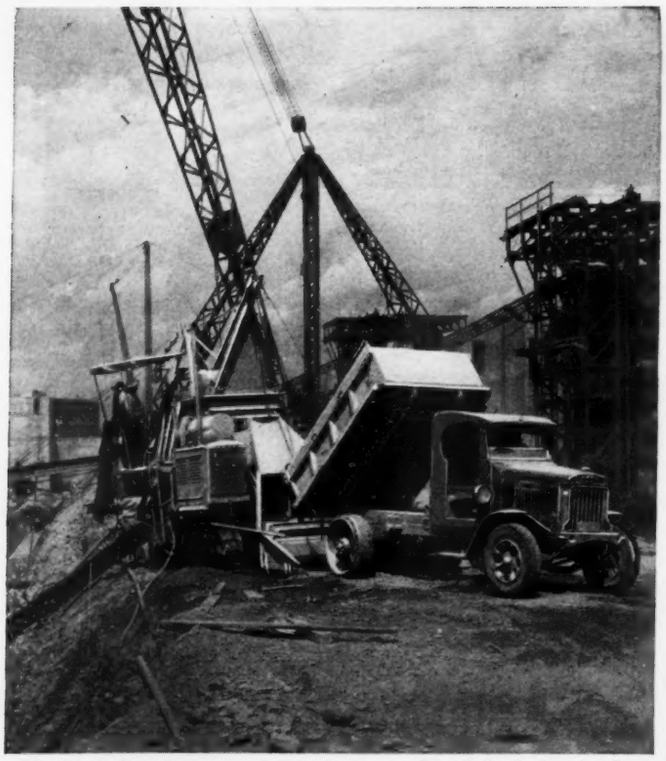

This Heavy-Duty International, one of many on this job, hauls three batches each trip. The scene shows one of the 30-foot sections of an Illinois Deep Waterway lock being poured

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Forget Your Concrete Curing Troubles

You can bid all your concrete curing troubles farewell forever by discarding the old, time-worn methods of curing. You can speed up construction, open your roads in half the time, cut costs, and know that your pavements will stand up under heavy traffic if you use Dowflake Calcium Chloride as your curing agent.

Dowflake is a clean, white, odorless flake that absorbs moisture from the air. It holds this moisture for long periods of time, accelerates the set of concrete and gives it a higher than normal early strength. Properly used, it reduces the tendency to surface voids and pitting and minimizes the freezing danger.

Dowflake gives remarkable results either as a surface curing agent or in the mix. And it is easy to handle and apply. Write for our free book, "How to Cure Concrete," and other information.

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

Be sure to visit the Dowflake Display at the Road Show, Atlantic City, January 11th to 17th inclusive.

PATENTED FEBRUARY 17 - 1925
DOWFLAKE
CALCIUM CHLORIDE
DOW

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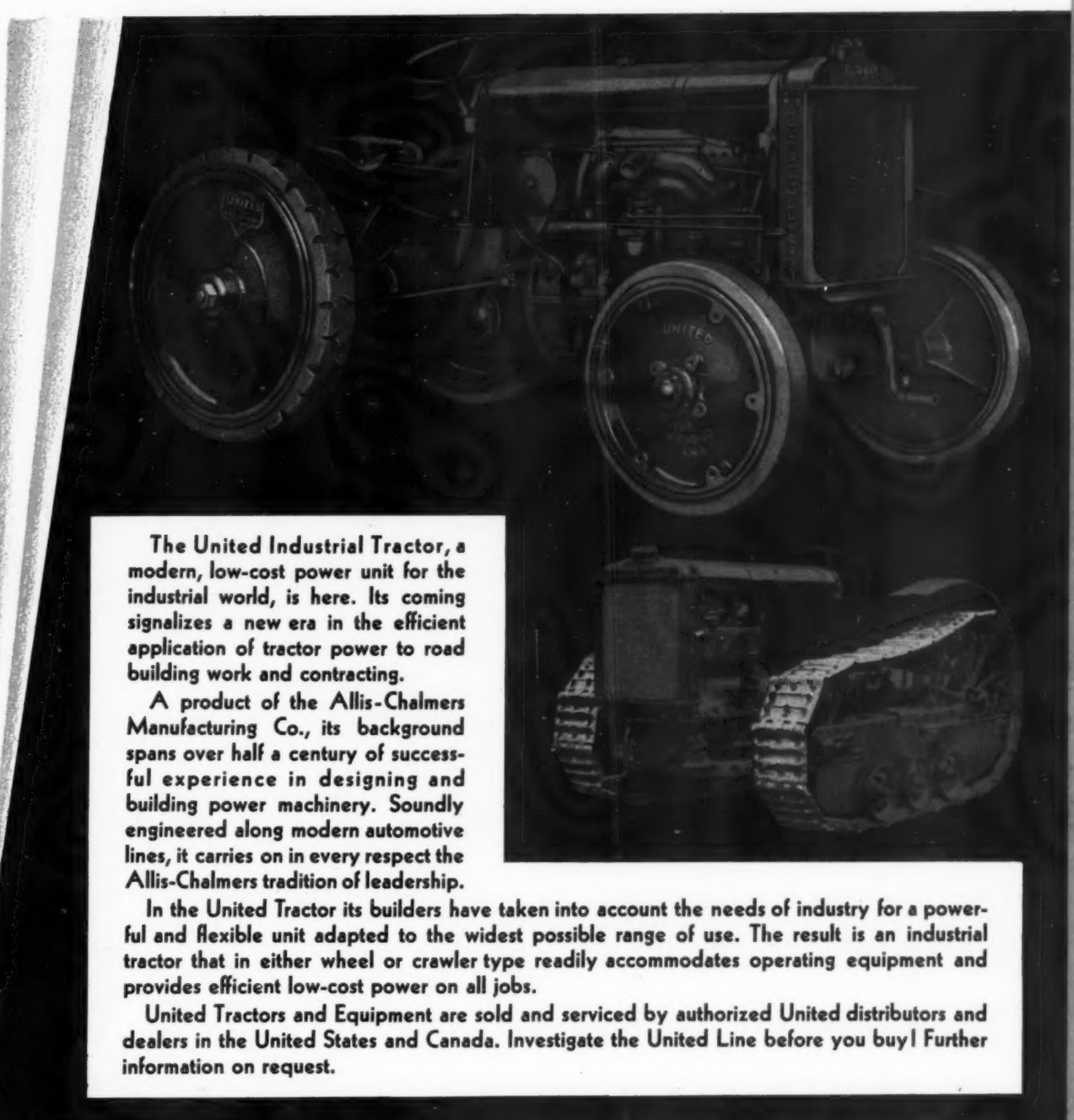
Now ready—

the UNITED Industrial Tractor



The United Industrial Tractor, a modern, low-cost power unit for the industrial world, is here. Its coming signalizes a new era in the efficient application of tractor power to road building work and contracting.

A product of the Allis-Chalmers Manufacturing Co., its background spans over half a century of successful experience in designing and building power machinery. Soundly engineered along modern automotive lines, it carries on in every respect the Allis-Chalmers tradition of leadership.

In the United Tractor its builders have taken into account the needs of industry for a powerful and flexible unit adapted to the widest possible range of use. The result is an industrial tractor that in either wheel or crawler type readily accommodates operating equipment and provides efficient low-cost power on all jobs.

United Tractors and Equipment are sold and serviced by authorized United distributors and dealers in the United States and Canada. Investigate the United Line before you buy! Further information on request.

UNITED TRACTOR & EQUIPMENT CORP.

612 NO. MICHIGAN AVE. CHICAGO, ILLINOIS.

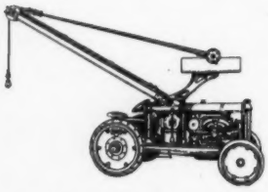
UNITED TRACTORS & EQUIPMENT

MANUFACTURING MEMBERS

ALLIS-CHALMERS MFG. CO.
BROOKVILLE LOCOMOTIVE CO.
DETROIT HARVESTER CO.
DORSEY BROTHERS
MAINE STEEL PRODUCTS CO.
MUSKOGEE IRON WORKS, INC.
NORTHWESTERN MFG. CO.
PERRY COMPANY
THE HUGHES-KEENAN CO.
TRACKSON COMPANY
UNIVERSAL POWER SHOVEL CO.
WEHR COMPANY

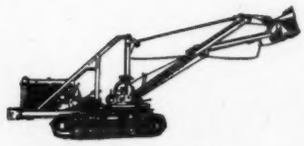
See the UNITED Line at the Atlantic City Road Show—January 13-18

UNITED OPERATING EQUIPMENT
Specially Built for the
UNITED INDUSTRIAL TRACTOR

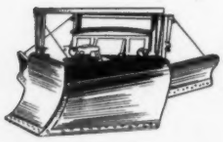


United Full Swing Crane
Built by
The Hughes-Keenan Co.

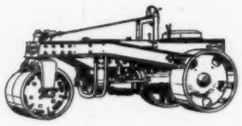
United Center Control Grader
Built by
Wehr Company



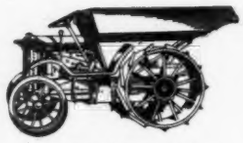
United Power Shovel
Built by
Universal Power Shovel Co.



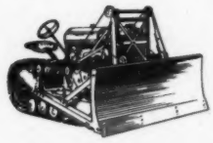
United Snow Plow
Built by
Maine Steel Products Co.



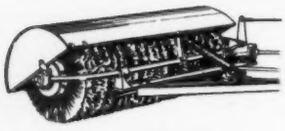
United Roller
Built by
Wehr Company



United Iron Mule
Built by
The Hughes-Keenan Co.

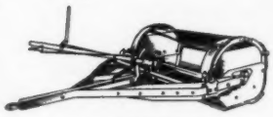


United Bulldozer
Built by
Trackson Company

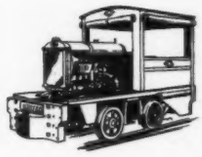


United Street Sweeper
Built by
Detroit Harvester Co.

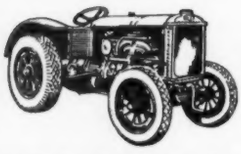
United Skidder
Built by
Dorsey Brothers



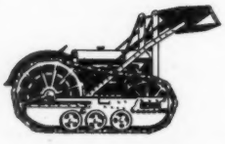
United Scraper
Built by
Perry Company



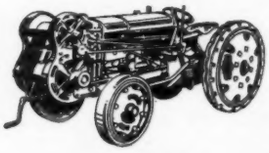
United Locomotive
Built by
Brookville Locomotive Co.



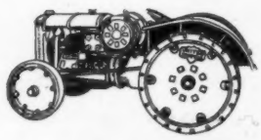
United Industrial Tractor
With Pneumatic Tires
Wheels Manufactured by
French & Hecht



United Front End Shovel
Built by
Trackson Company



United Hoist
Built by
Muskogee Iron Works, Inc.



United Arc Welder
Built by
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For use with this revolutionary tractor, there is a complete line of operating equipment built especially for the United Tractor.

Each unit is an outstanding achievement of a specialized builder of road and contracting equipment. Masterful in performance, low in first cost, economical to operate and maintain, United Tractors and Equipment are Champions of every job!

UNITED TRACTOR & EQUIPMENT CORP.

612 NO. MICHIGAN AVE. CHICAGO, ILLINOIS.

See the UNITED Line at the Atlantic City Road Show—January 13-18

That's an *Elastite* product there!

THE heavily traveled, surface-smooth Avenue "U" at Brooklyn, N. Y. Protected against expansion and contraction stresses by Carey Elastite Expansion Joint, installed longitudinally as well as transversely.

And that's why the road — stays — so — smooth

THE concrete is wrinkle-proofed—perfectly and permanently protected by Carey Elastite Expansion Joint. Notice that the joints are installed lengthwise as well as transversely—a doubly effective safeguard against expansion and contraction strains.

CAREY ELASTITE EXPANSION JOINT is made in sandwich form. An inner filling of special asphalt composition, holding outer-sheets of asphalt-saturated felt, both prepared at Carey's own plant and preformed under pressure. Easily installed, in any weather. Its protection is lasting and its cost is but a fraction of the finished construction job. Write for particulars on Expansion Joint installation.

THE PHILIP CAREY COMPANY, *Lockland,* CINCINNATI, OHIO

Carey Elastite EXPANSION JOINT

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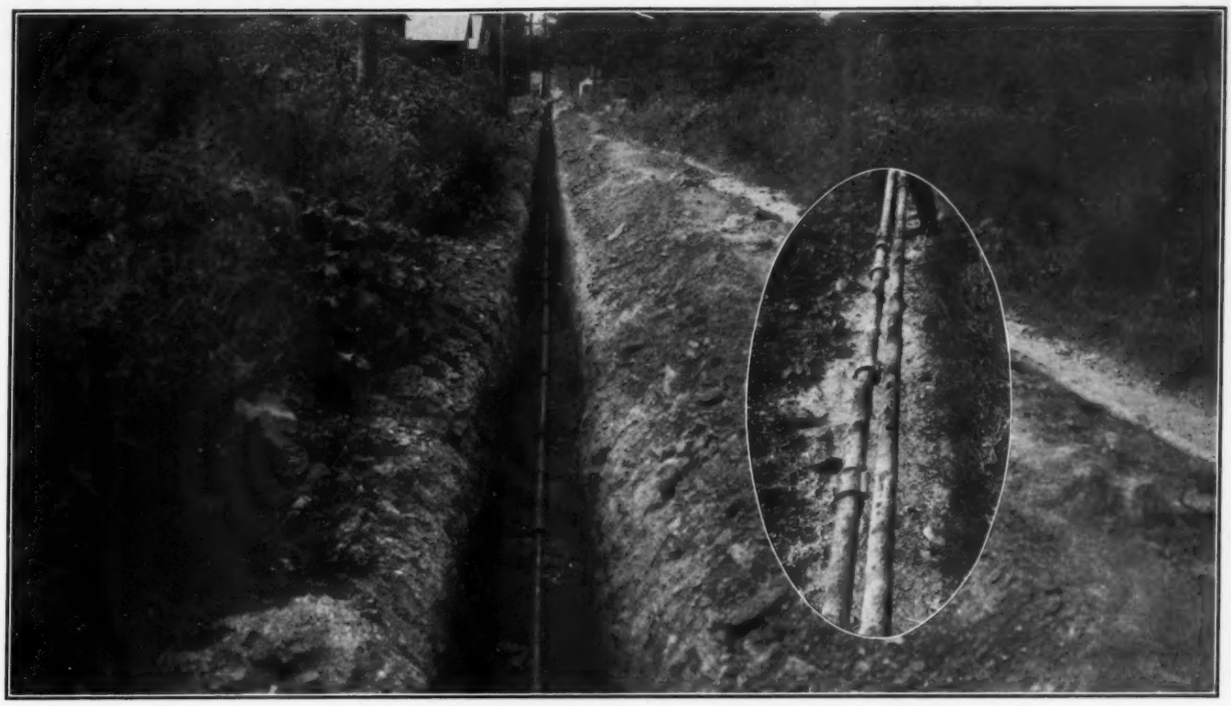


Another Proof!

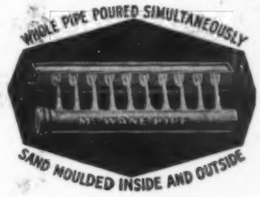
The oval-shaped insert tells the tale. Again McWANE 2-inch CAST IRON PIPE goes in to replace a "temporary" line so badly rusted that repairs have become impossible.

With McWane 2-inch cast iron pipe available now in 18-foot laying lengths, with the famous Precalked Joints insuring a speed and cost of laying equal or better than any other pipe, why not lay PERMANENT pipe hereafter?

For no piece of cast iron pipe—whether 2-inch or 12-inch—has ever been known to wear out in ordinary service. McWane 2-inch pipe can be taken up and relaid elsewhere later if desired. In any event, "it will **last,** because it's **cast.**"

McWane Pipe is cast in sizes 1¼ to 12 inches inclusive. Standard lengths. For fullest competition in pipe-buying, include "McWane Pipe" in specifications.

For larger mains, McWane also offers genuine sand cast bell and spigot type pipe—with or without the famous Precalked Joints. Modern weights and strengths plus all the sturdy virtues of old fashioned sand cast pipe. Cuts, taps, and ships unusually well. Prompt shipments from two foundries guarantees quick service. Fittings, too,—Precalked or with open bells.



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BIRMINGHAM, ALA.

PACIFIC STATES CAST IRON PIPE CO.
PROVO, UTAH.

SALES OFFICES IN PRINCIPAL CITIES

McWANE
CAST IRON PIPE

In test at Sanford, Fla.
F-M Diesels show economies

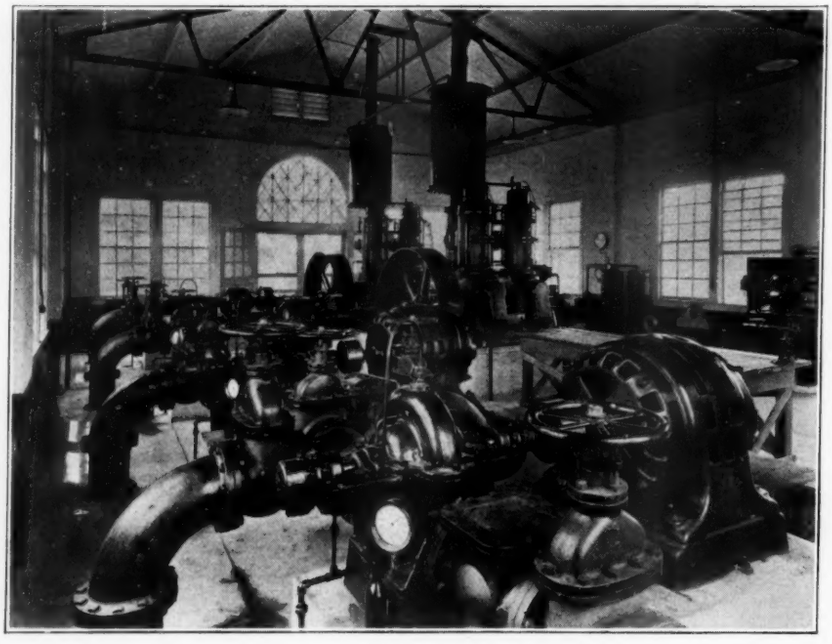
In 1924 the city of Sanford installed a new waterworks plant. A Fairbanks-Morse layout including Diesels, Pumps and Motors was chosen by the consulting engineer in charge.

Two Fairbanks-Morse Pumps, each handling 2100 g.p.m. against a 130-ft. head and gear driven by two 100 hp. F-M Diesels, constitute the main pumping equipment. Standby equipment consists of two F-M Pumps of the same capacity and type, each driven by an F-M 100 hp. Slip-ring Motor.

A direct comparison has been made between the cost of Diesel and purchased power operation with identical pumps operating at full capacity for one month.

	1. Diesel Driven Pumps	2. Motor Driven Pumps with purchased current
Length of run	265 hrs. 34 min.	261 hrs, 56 min.
Water pumped	33,461,100 gal.	33,003,600 gal.
Power cost for the month...	$123.38	$551.25

Identical pumping units were the basis of this comparative test.



The saving to the city is $427.87 per month!

City officials are finding Fairbanks-Morse Diesels a certain method of rendering adequate service and keeping costs and taxes low. F-M engineers will gladly aid in the solution of municipal power problems involving the necessity of cost reduction.

FAIRBANKS, MORSE & CO.

900 S. Wabash Avenue, Chicago

32 branches at your service throughout the United States

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DIESEL ENGINES

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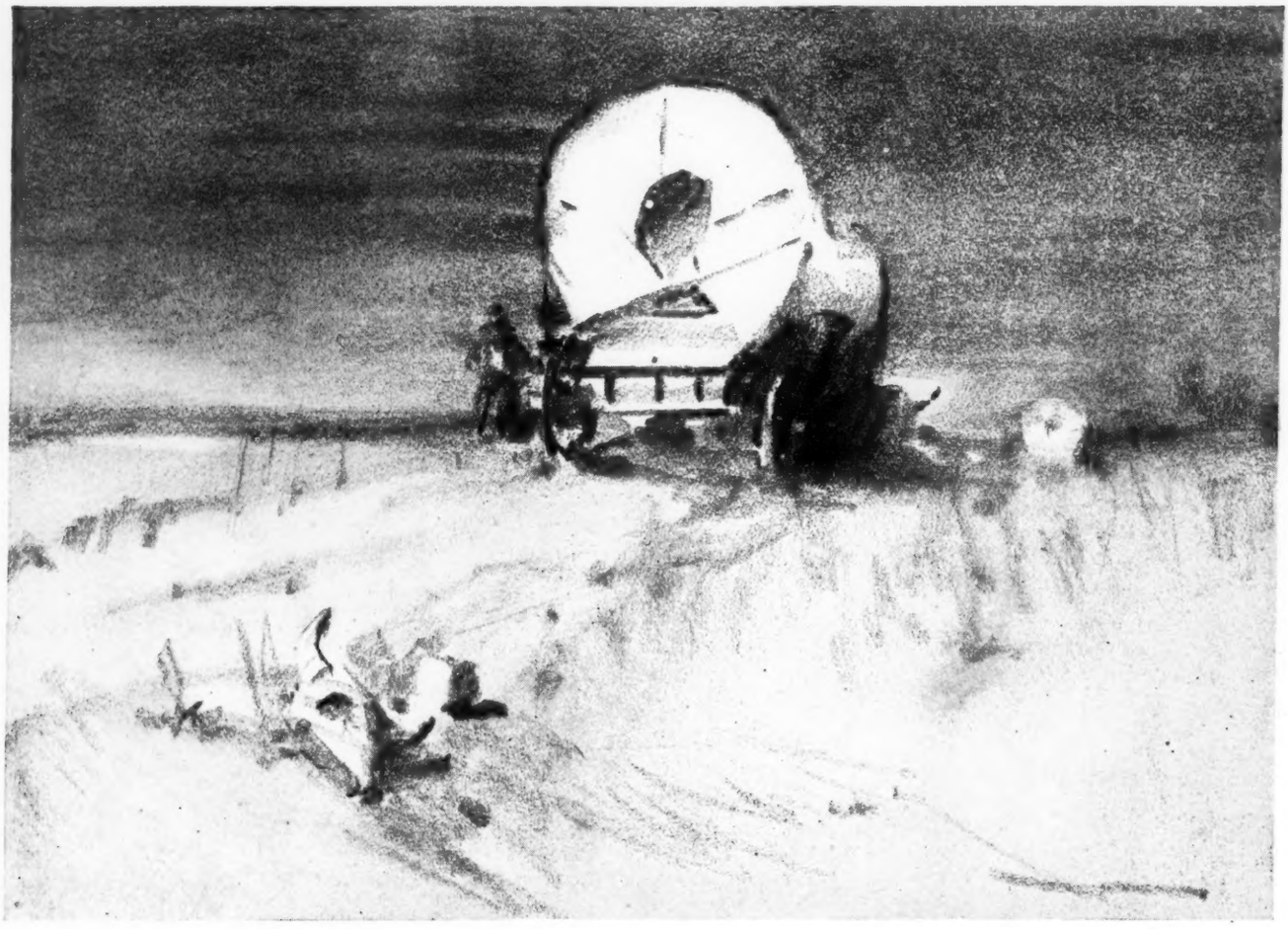
PUBLIC WORKS

CITY COUNTY STATE

DECEMBER, 1929



Since wagon roads were made from buffalo trails—

From the age of the pioneer, when wagon roads were made from buffalo trails—an unbroken chain of service connects Austin-Western with modern progress—the age of the engineer!

The tradition of the Austin-Western Road Machinery of today has been growing steadily from a time when the threat of the Indian hung over blue forests and great rolling plains—before there were railroads west of the Missouri.

Over seventy years of close contact with the problems of building and maintaining roads that have changed the face of a continent have brought to Austin-Western engineers a rich heritage of knowledge based on experience.

Year by year, new materials and ripened experience combine to bring about improvements in both product and methods that are of far-reaching importance to everyone concerned with building, using or paying for roads.

Those leaders in the road building field who for years have looked to Austin-Western for the most advanced pronouncements in road construction and maintenance equipment will not be disappointed in 1930. Announcement of further refinements in *the most complete line of road machinery ever offered to road builders* will be made shortly after the first of the year. The Austin-Western Road Machinery Co., 400 North Michigan Avenue, Chicago, Illinois. Branches in Principal Cities.

1930 Convention and Road Show, A. R. B. A., Atlantic City, N. J., January 13 to 18

Austin-Western
ROAD MACHINERY

VOL. 60 No. 12
Entered as second-class matter at the Pose Office at New York, N. Y., Sept. 1, 1922, under the Act of March 3, 1879.
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IN the FWD Truck you get a complete . . . dependable . . . all-purpose power unit. One that will economically cope with the "toughest" of your road jobs . . . one that is built to stand the use and abuse of heavy service.

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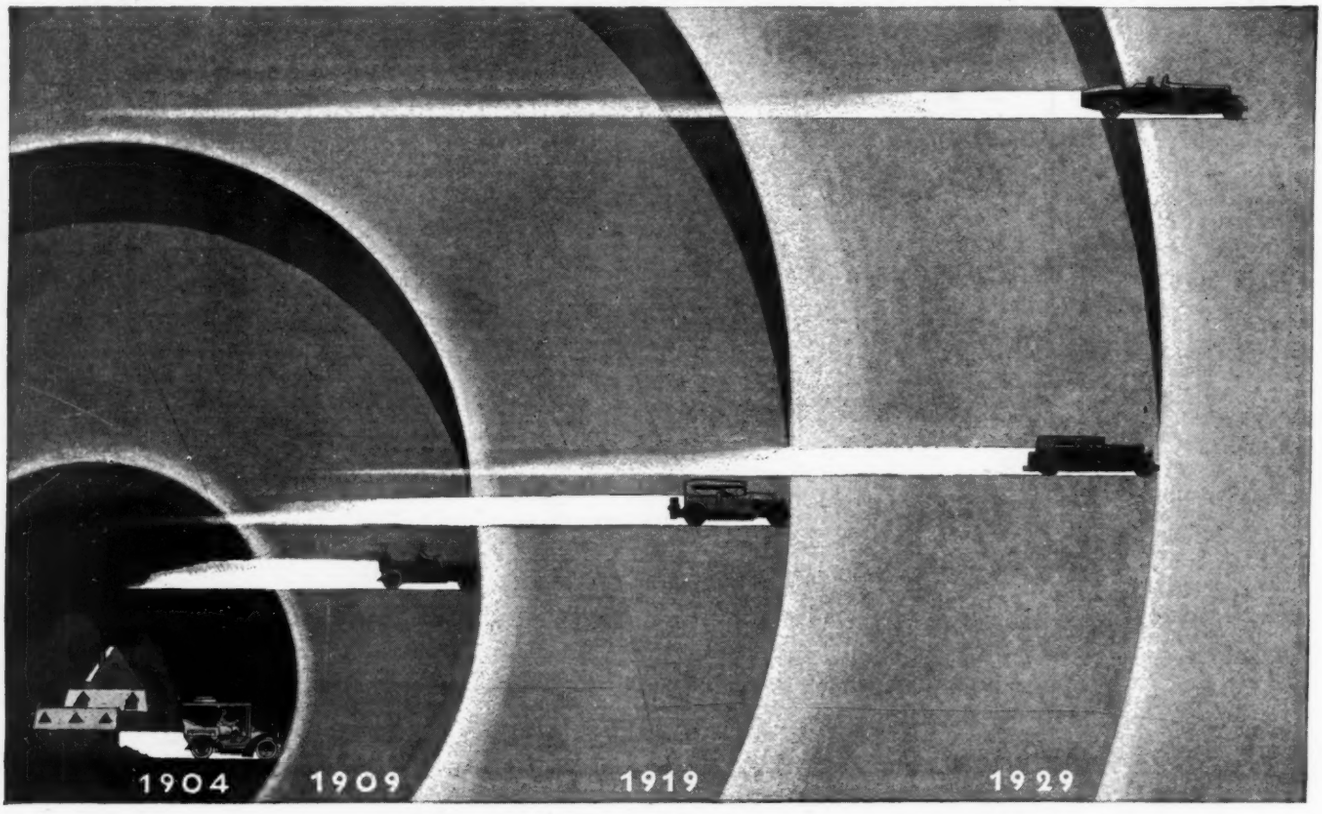

TEN years ago, the average day's run of the motor tourist was 110 miles. Today it is 234 miles. There are not a few purposeful pilots who do 500 miles in a single day's going. What a contrast with 1909—when our country consisted largely of people limited to a daily radius of 15 miles!

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But automobiles are increasing faster than pavements. More and wider roads—not just more and faster automobiles—are needed.

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REPAIR and MAINTENANCE

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